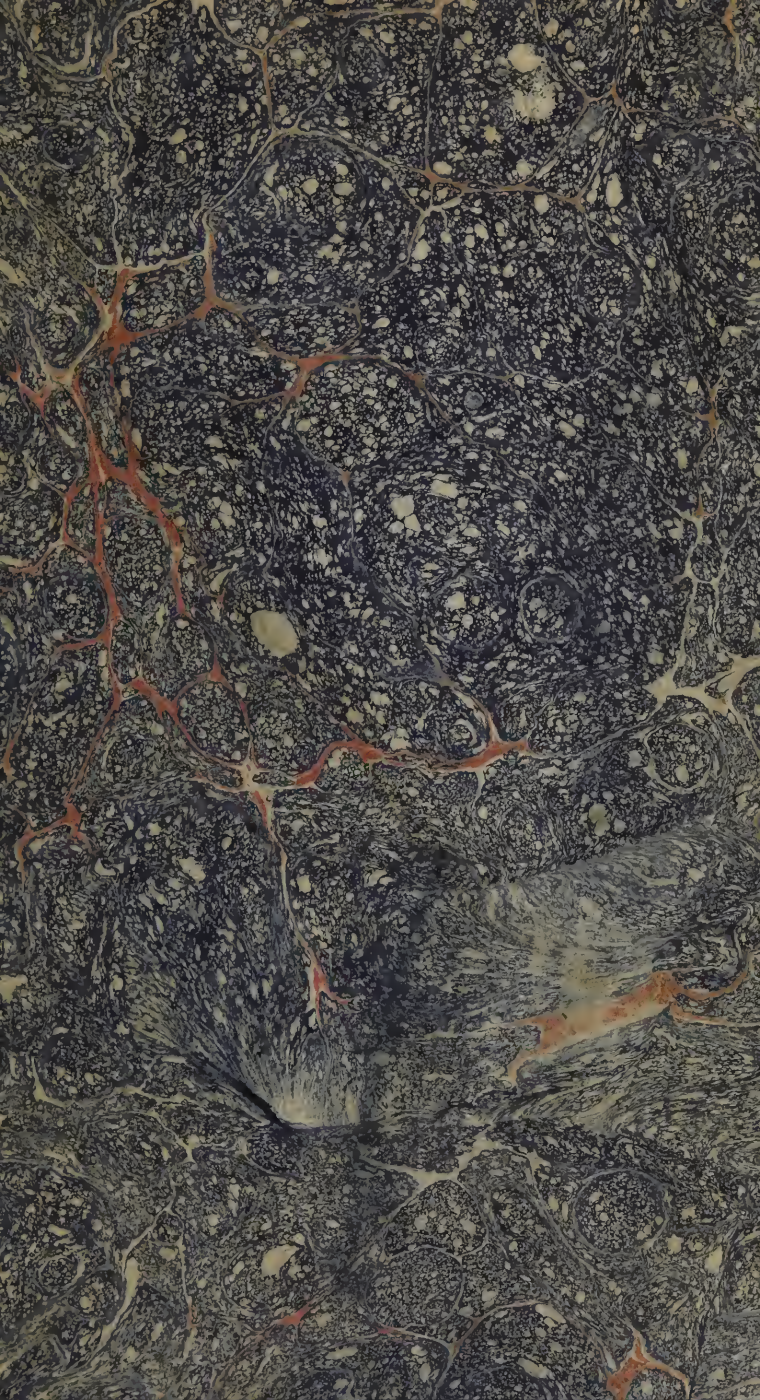

A

# DISSERTATION

ON THE

CHYMICAL PROPERTIES AND EXHILARATING

EFFECTS

OF

NITROUS OXIDE GAS.

To

Mrs. Decatur,

from

the Author.

August 27th 1809

A

# DISSERTATION

ON

# THE CHYMICAL PROPERTIES

AND

# EXHILARATING EFFECTS

OF

# NITROUS OXIDE GAS;

AND ITS

# APPLICATION TO PNEUMATICK MEDICINE;

SUBMITTED AS

## AN INAUGURAL THESIS

FOR

THE DEGREE OF DOCTOR OF MEDICINE

---

BY WILLIAM P. C. BARTON, A. B.

OF PHILADELPHIA;

HONORARY MEMBER OF THE PHILADELPHIA MEDICAL SOCIETY;
MEMBER OF THE PHILADELPHIA MEDICAL LYCEUM; AND
OF THE PHILADELPHIA LINNEAN SOCIETY.

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"CAUSA LATET, VIS EST NOTISSIMA."

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PHILADELPHIA:

PRINTED FOR THE AUTHOR, AT THE LORENZO PRESS.

1808.

AN

# INAUGURAL DISSERTATION

FOR

THE DEGREE

OF

DOCTOR OF MEDICINE;

SUBMITTED

TO THE EXAMINATION

OF

JOHN M'DOWELL, L.L.D. PROVOST,

THE

TRUSTEES AND MEDICAL PROFESSORS

OF THE

*UNIVERSITY OF PENNSYLVANIA,*

ON THE

TWENTY-SEVENTH DAY OF APRIL,

1808.

TO

BENJAMIN SMITH BARTON, M. D.

PROFESSOR OF MATERIA MEDICA, NATURAL HISTORY, AND BOTANY, IN THE UNIVERSITY OF PENNSYLVANIA:

THE FOLLOWING PAGES,

THE INAUGURAL FRUITS OF A MEDICAL EDUCATION CONDUCTED UNDER HIS CARE,

ARE,

WITH SENTIMENTS OF THE HIGHEST VENERATION FOR HIS TALENTS,

RESPECTFULLY DEDICATED;

AS A TRIBUTE

OF FRIENDSHIP, GRATITUDE, AND ESTEEM,

*BY HIS AFFECTIONATE*

*PUPIL AND NEPHEW,*

*WILLIAM P. C. BARTON.*

TO

WILLIAM BARTON, A. M. ESQUIRE,

MEMBER OF THE AMERICAN PHILOSOPHICAL SOCIETY, AND OF THE ROYAL ECONOMICAL SOCIETY, VALENCIA, SPAIN:

DEAR SIR,

THE sentiments of gratitude and filial love which I feel towards the best of fathers, would find but an unworthy tablet for their inscription, in the too frequently prostituted page of dedication. But at such a period as the present, which conducts me to the final completion of my education, I cannot forbear to proffer you a publick memento of those feelings which glow with too much fervour to admit delineation. To you, then, I inscribe this little essay, as the genuine offering of the heart. Receive it with the sincere regard, of

Your affectionate

Son,

WILLIAM P. C. BARTON.

TO

THE REV. SAMUEL STANHOPE SMITH, D. D.

PRESIDENT OF PRINCETON COLLEGE,

AND

PROFESSOR OF MORAL PHILOSOPHY AND BELLES LETTRES IN THE SAME:

*This Essay is also Dedicated,*

AS

A SINCERE TRIBUTE

OF

*Gratitude and Affection,*

FOR THE MANY PROOFS OF DISINTERESTED FRIENDSHIP, WHICH, IN THE TWO-FOLD CHARACTER OF

PRECEPTOR AND FRIEND,

HE EVINCED TOWARDS

HIS EVER GRATEFUL PUPIL

THE AUTHOR.

# PREFACE.

THE walks of Pneumatick Chymistry were first entered and explored by one, whose genius, like a star of dazzling resplendence, shines with conspicuous lustre in the galaxy of his brilliant cotemporaries. We allude to the philosophick Priestley and his memorable researches. Among the discoveries which resulted from his earliest exertions, may be considered the gas that constitutes the subject of the following essay. Its properties, however, were afterwards investigated with more accuracy, and ascertained with greater certainty by the celebrated Davy. Through the ardent zeal and unwearied industry of the latter, much light was thrown on this new and obscure department of science. Of the nitrous oxide, he found when respired, that it possessed the power of inducing the most extraordinary effects, both on the mind and body. But the account which he gave of its operation was generally derided as extravagant and imaginary. Few believed it. The description was supposed to have proceeded from a warmed and highly excited mind; and that there was told respecting the gas

——— "every idle thing
That fancy finds in her excursive flight."

Experiments repeatedly performed by Mr. Davy, and confirmed by other chymists, did not remove the distrust. Poetry indeed was enlisted to expose the delusion as it was termed, and to laugh it into contempt. This task was undertaken and executed with singular ability, in a work which emulates very successfully, the happiest effusions of Hudibrastick satire.*

In the United States the chymists partook of the prevalent skepticism as to the alleged qualities of the gas. Nor was it subdued till a series of conclusive experiments was made by professor Woodhouse. No doubt, however, can any longer be retained, even by the most incredulous. The experiments already referred to, strengthened by those which are to be related in the subsequent pages, settle the point beyond disputation or denial.

As, therefore, the wonderful properties of the gas have been thus incontrovertibly established, we have conceived that it would not be altogether an unprofitable employment to collect and to present, in one view, all the most interesting matter relating to it; much of which, at present, is diffused in light and fugitive publications that are difficult of access, and by many in this country, not at all to be procured. We confess, moreover, that we feel a strong desire to direct the attention of physicians to the subject, with the hope that the gas may be tried more extensively as a remedy in the treatment of diseases. Little has hitherto been done in this respect. A wide extended field still remains open, which

* Terrible Tractoration.

promises no contemptible harvest to the diligent cultivator.

It may confidently be expected of every agent which acts powerfully on the living system, that when we attain a sufficient knowledge of its qualities to enable us to apply it with proper discrimination, and to temper its operation judiciously, that it will prove eminently beneficial as a medicine. The whole catalogue of our active remedies is illustrative of the position. Hence it has become a medical aphorism, that "Poisons are the best medicines." No substance with which we are acquainted, holds out a fairer prospect than this gas, of being useful. Its mode of operation is peculiar and distinct. Both to the mind and body it imparts a force and vivacity of stimulation that is produced by no other substance; and, whatever may be the degree of excitation, it is not succeeded by the debility or sypmtoms of turgescency which are the uniform consequences of the rest of the diffusible stimulants. This singularity of property alone, gives to the gas the strongest claim to medical regard.

We have already explained the motives which induce us to compile and to publish, the present essay. Among them, we trust nothing like an overweening vanity can be detected. We are on the contrary, perfectly sensible of its defects; and as we do not pretend to have offered to the publick any thing very deserving their attention, we submit it to their notice with very unaffected diffidence. While, howver, we entreat their candid and ingenuous criticism, we cannot but deprecate the overstrained accuracy of

the scowling hypercritick, with its merited aversion. Let it be remembered that science, from its most inferiour base to its towering acme, is but a collected mass of minute parts. Even the great Caucasus is a heap built up of little sands. We come to add our humble mite to the colossal mass of chymical science. *Trahit quodcunque potest, atque addit acervo.* * We cannot but express a hope that the subject of the following pages, will receive a future and more perfect prosecution. The field is extensive and inviting, and though partially cultivated, still contains much rich, but untilled soil. By the hand of zealous industry it may be made to yield a yet more luxuriant and abundant harvest; and if our humble endeavours have but turned a single clod of earth, or added a single ear to the ripened sheaf, we shall feel most justly, most amply compensated.

* Horace.

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## SECTION VII.

## *ADVERTISEMENT.*

*THE reader will perceive that in treating the subject of the following dissertation, I have adopted the nomenclature used by Dr. Thompson in his Chymistry; universally employing the term nitric oxide for nitrous gas, or fuming nitrous acid. I have done this as well with a view to uniformity, as because it is unquestionably the more elegant and perspicuous method; the different degrees of oxidizement of azote being, I think, most clearly expressed by the terms nitrous oxide, nitric oxide, and nitric acid, than when the second degree of oxygenation is designated by the words nitrous gas, or nitrous air.*

# A DISSERTATION, &c.

## SECTION FIRST.

## HISTORY.

NITROUS Oxide Gas was first discovered by the illustrious Dr. Priestly, in the year 1776, a period at which he made his earliest researches into the unexplored regions of pneumatick chymistry. He called it dephlogisticated nitrous air, and concluded, from the experiments he performed with it, that it was not respirable. This opinion is, I apprehend, completely refuted by a series of well conducted experiments made some years since in England by Mr. Davy, as well as by those of a more recent date, performed in Toulouse in France, in Philadelphia, and New York. A particular detail of those made in this city will be given in another place; and it will appear that the Doctor employed a less pure agent than that made use of by late experimenters. The associated Dutch chymists gave it the name of gaseous oxide of azote, and investigated its properties in Amsterdam during the year 1793; it is probable, however, that they experimented with an equally impure substance,

since they likewise supposed it unfit for respiration. That such was in reality the case, will be satisfactorily demonstrated by a review of the experiments just alluded to. From their researches into the nature of this gas, it appeared that it was composed of oxygene and azote.* In the year 1798, the celebrated Mr. Humphrey Davy of London, whose exertions and indefatigable zeal have contributed so largely to our knowledge of the gasses, whilst yet in his infancy as to chymical pursuits, turned his attention to the investigation of this subject. His first experiments upon the physiological effects of the gas were made on the mixtures of nitrous oxide, azote, and nitric oxide, which are generated during metallick solutions, because he was not at that period, nor indeed for a considerable time subsequent to it, enabled to obtain the first of these airs in a state of entire purity. The indefatigable labours of his mind, and his undivided attention were for some time directed to the ascertainment of the nature and properties of this substance. He found that it was not only respirable for a limited time, but discovered that it was possessed of a peculiarly exhilarating property and invigorating effect. This he proved by a number of unequivocal experiments on himself and others, the results of which he gave to the world in his invaluable "Researches." He has in that publication left scarcely any thing else to be said with respect to this wonderful air, which he calls nitrous oxide. Dr. Samuel L. Mitchell, of New York, adopted the name of gaseous oxide of azote, and assumed it as the fundamental principle of the

* Jour. de Phys. xlii. 323.

the matter of contagion. His theory,* though extremely ingenious, was too hypothetically formed to stand the rigid test of philosophick scrutiny, and it was of consequence soon exploded. Such, indeed, must be the inevitable fate of all speculations deduced from vague and gratuitous premises, instead of the surer basis of incontrovertible fact.

Some experiments were made with this air by a society of amateurs at Toulouse, whose results corroborating those of Mr. Davy's experiments, confirm the truth of the latter; and recently a few have been performed by professor Silliman of Yale college, Connecticut, from which similar conclusions are deducible. Others of a latter date have been made in New York and Philadelphia, which perfectly coincide in their results with those just mentioned.

The following extract from a new and valuable edition of Chaptall's Chymistry, by professor Woodhouse, will finish this brief historical account of the gas.

* He supposed that dephlogisticated nitrous gas, which he called gaseous oxide of septon (i. e. oxide of azote) was the principle of contagion, and capable of inducing the most deleterious effects, when respired by animals, or even when applied to the skin or muscular fibre. He asserted that when a full inspiration of it was taken into the lungs, it immediately extinguished animal life; and on the strength of this position, attempted to account for a fact mentioned by Russel in his History of Aleppo, page 232, that many persons, when struck with the contagious miasma of plague, fell down suddenly dead.

"In the year 1802," says Dr. Woodhouse, "I prepared a large quantity of the nitrous oxide, or dephlogisticated nitrous air, from the nitrate of ammoniac, made by decomposing nitre, by the sulphate of ammoniac and by adding the nitric acid to sal-ammoniac.

"A great number of gentlemen, belonging to my chymical class, who intended to breathe the gas, were present in the morning when I was filling my air holders with it, and saw all the operations going forward. In the afternoon, being alone at my laboratory, at two o'clock the air was examined and found to be extremely impure, having made use of too great a degree of heat in generating it.

"Expecting the gentlemen at three o'clock, the impure air was thrown away, and the air holders filled with atmospheric air.

"This air was breathed by a variety of persons, under the impression that it was the nitrous oxide and the greater part of them were affected with quickness of pulse, dizziness, vertigo, tinnitus aurium, difficulty of breathing, anxiety about the breast, &c. The following is a letter received from one of the gentlemen:

"The nitrous oxide produced no sensible effect, for perhaps the space of a minute after I began to respire it. Soon after, I was affected with a tinnitus aurium which affected the sense of hearing, in the same manner as water, in a state immediately preceding ebullition, does. At the same time I had a sensation

similar to that produced by swinging; afterwards a difficulty of breathing gradually came on, which at length necessitated me to discontinue the respiration of the air. The difficulty of breathing and the tinnitus then soon subsided; but the peculiar sensation in my breast continued some time longer, which was succeeded by slight nausea, which continued six or eight hours."*

* When I heard this letter read from the chymical chair, and reflected upon the palpable improbability that any sane man, for the support of a preconceived result of an experiment, should thus voluntarily forfeit his veracity, by so gross a deception as that of deliberately delineating on paper, feelings which he had not in any degree experienced, I could not help thinking that we were too rash in concluding that the effects described were entirely imaginary. And although I firmly believed that the most wonderful of these sensations were the hallucinations of a heated and creative fancy; yet I was inclined to suspect that they were not altogether without foundation. I resolved however to submit this opinion to the test of experiment, and the following one will prove how just was my suspicion. I inflated a bladder containing three quarts with atmospheric air, and closing my nostrils, inhaled it from and into the bladder. I did not, indeed, become vertiginous, as did the writer of the letter; but soon experienced great anxiety in my breast, and so great a difficulty of breathing as to induce a sense of suffocation, which rendered it impracticable to continue the respiration any longer. I felt oppressed about the præcordia for a considerable time after ceasing to respire from the bladder. These effects are at once explained when we advert to the nature of the expired gasses after the decomposition of the air in the lungs, viz. azotic and carbonic acid gasses, both of which are fatal to animal life. Of the azote, there must be no inconsiderable quantity, if it be true as is generally supposed,* that this subtance is a mere diluent of

* Mr. Davy is the only person who maintains a contrary opinion. He asserts that it is taken into the lungs and is mixed with the mass of circulating blood.

"A short account of the effects of the atmospheric air, was sent to Dr. Mitchell, of New York, who published it in the fifth volume of the Medical Repository."

Dr. Woodhouse concludes this account by stating, that not having for many years met with any experiments confirming those of Mr. Davy, he had supposed that the sensations described by him and others, were the offspring of the imagination; but that the experiments he had lately witnessed, convinced him he had been in an errour. He declares that their results were, in every circumstance, corroborative of Mr. Davy's account.

## PREPARATION.

THE nitrous oxide is prepared for the purposes of respiration by decomposing the nitrat of ammonia.* This nitrat of ammonia may be formed in different ways. 1st. By adding the nitrat of potass to a saturated solution of the sulphat of ammonia. Here a double elective attraction takes place. The sulphuric acid of the sulphat of ammonia, unites

the oxygene and entirely passive in respiration; for here it will all be collected in the bladder when expired.

Thus much in excuse for the writer of the letter, who only exaggerated his real sensations, or deviated from the truth, when he told us of the tinnitus aurium, &c. &c.

* Fourcroy places this salt among the *nitrits*. He, however, is the only author who has assigned its classification among these substances.

to the potass and forms sulphat of potass, or vitriolated tartar, while the nitric acid of the nitre unites to the ammonia and forms nitrat of ammonia, which remains in the supernatant liquor, after the vitriolated tartar is crystallized;† and by evaporation at 212° the nitrat of ammonia is obtained in needle-formed crystals.

2d. It may be made by adding nitric acid to sal ammoniac. The rationale of this process is thus. The nitric acid unites to the ammonia of the sal ammoniac, and forms the nitrat of ammonia, while the muriatic acid of the muriat of ammonia escapes in the form of gas. The fumes are perceptible from their smell.

3d. It may be produced by uniting volatile alkali with nitrous acid vapours.

4th. It may be made by the direct combination of nitric acid with carbonat of ammonia, or the concrete volatile alkali of the shops. This is much the best mode of preparing the salt. Here, the nitric acid unites to the ammonia of the carbonat of ammonia, and forms the nitrat of ammonia; while the carbonic acid escapes in the form of gas, which, as soon as it reaches the top of the vessel, falls over its sides, being specifically heavier than atmospheric air.

The nitrat of ammonia, produced by either of these methods, differs in appearance according to the

† This crystallization is to be effected by two evaporations at the temperature of 250°.

various temperatures at which its solution is evaporated. If this evaporation is effected by a heat of 70° or 80° and the mass cooled slowly, the nitrat of ammonia will be formed into six-sided prisms, terminated by six-sided pyramids. A temperature of 212° employed in evaporating the solution will procure the salt in channelled crystals of a fibrous texture, or they will be formed of long, soft, elastick threads. By a heat of about 300° it is obtained in a white compact mass. It has an acrid, bitter, and disagreeable taste; is soluble in two parts of water at a temperature of 60° of Farenheit; half its weight of boiling water dissolves it; and it deliquiates when exposed to the action of atmospheric air. Exposed to the fire, it fuses, dries, and then detonates.* A temperature below 300° renders it fluid when it is in prysmatick crystals; between 380° and 400° it boils without decomposition; but is gradually decomposed by a heat of 450°, and this decomposition does not deprive it of its water of crystallization. A temperature higher than 260° is necessary to effect any change in the compact salt. Between 275° and 300° it sublimes slowly, without decomposition. A temperature of 320° melts, and slowly decomposes it. When it is exposed to a heat above 500°, it is converted into the nitrous oxide. When this gas is to be procured we are to put the salt, whether it be conformed in six-sided prisms, or obtained in a concrete mass, into a retort; and a heat is to be applied, not greater than 500°, nor less than 340°. This may be done by means of an Argand's lamp. It soon melts rapidly, is decomposed, and resolved into a fluid and a gas.

* Parkinson's Chymical Pocket Book, p. 36.

The first has a faint taste, and contains generally some undecompounded nitrat. The second is eliminated from the mouth of the receiver in large quantities, and is to be collected either in jars filled with, and inverted over water, or in air-holders; the latter is the preferable method. The gas which comes over in the commencement of the process, differs somewhat from nitrous oxide, but is not exactly nitric oxide;* this portion ought, therefore, always to be thrown away; the next portions which come over are pure nitrous oxide.

During the decomposition of the compact nitrat of ammonia, no luminous appearance is visible in the retort, but an intense heat is generated.

When the concrete nitrat of ammonia is exposed to a heat above 600°, it explodes in a violent manner, and is converted into nitrous acid, nitric oxide, water, and azotic gas; hence it is called *nitrum flammans*.†

When large quantities of nitrous oxide are wanted for the purposes of respiration, it is advisable to employ the fibrous nitrat of ammonia, because this salt undergoes no decomposition till the greater part of its water of crystallization is evaporated; and, therefore, at the commencement of that process is uniformly heated. The gas produced from it, however, should not be used for an hour after it is generated; because, before this time, it contains more or less of a white

* Proust.

† Woodhouse's edition of Chaptall's Chymistry, Vol. I. page 178.

vapour, which irritates the fauces and lungs, inducing coughing. This vapour consists probably of acid nitrat of ammonia and water.* The last portions of gas generally contain less of this vapour.

The nitrat of ammonia should not be decomposed in any common metallick vessels, because the free nitric acid will be decomposed, and, of course, nitric oxide produced.

A pound of fibrous nitrat of ammonia decomposed at a heat not exceeding 500°, produces nearly five cubick feet of gas; whilst from a pound of compact nitrat, rarely more than 4.25 cubick feet are obtained.†

The rationale of the process by which nitrous oxide is obtained, in consequence of the decomposition of nitrat of ammonia, is as follows: This salt is possessed of four affinities,‡ viz. 1. That of hydrogene and azote, producing ammonia. 2. That of oxygene for nitric oxide, producing nitric acid. 3. That of the hydrogene of ammonia for the oxygene of nitric acid. 4. That of the azote of ammonia for the nitric oxide of the nitric acid. Now by a temperature of 400°, the equilibrium between these affinities is destroyed; the attractions of hydrogene for azote, and of nitric oxide for oxygene, are diminished; whilst the attraction of the hydrogene for oxygene is increased; and perhaps that of azote for nitric oxide. Hence part of the oxygene of the ni-

* Davy, p. 118.

† Davy, p. 121.

‡ Davy, p. 114.

tric acid of the nitrat of ammonia, unites with the hydrogene of the ammonia to generate water; and the azote enters into combination either with another part of the oxygene of the acid, or the nitric oxide to form nitrous oxide; and the water and nitrous oxide produced, are supposed by Mr. Davy to exist in binary combination in the aëriform state at the temperature of the decomposition.*

The nitrous oxide is always an artificial production.

## OF ITS PRODUCTION

### FROM NITRIC OXIDE, AND NITRIC ACID, IN DIFFERENT MODES.†

IT may be obtained by confining the following substances for a week or two in jars containing nitric oxide gas:

Alkaline Sulphites.

Hydrogenated Sulphures.

Muriat of Tin.

Sulphurated hydrogene gas.

Iron or Zinc filings moistened with water.

* Researches, p. 115.

† Vide Davy's Researches.

This last mode is a very uncertain one, because if there be too much iron, the oxygene of the nitric oxide might be altogether absorbed, and the residual air would be pure azotic gas; and if there be too small a quantity of iron, a sufficiency of oxygene would not be absorbed, to de-oxygenate the nitric oxide. In all these cases, the substances just mentioned, gradually combine with that portion of oxygene which makes the nitrous oxide, nitric oxide, and are converted into oxides or salts,* whilst the nitrous oxide is the gas which remains unabsorbed.

Priestly obtained it by placing the nitric oxide in contact with moistened iron filings, or the alkaline sulphures—and Kirwan, by exposing it to sulphurated hydrogene. The Dutch chymists supposed that nitrous oxide was generated from nitric oxide, simply by the abstraction of a portion of its oxygene. They procured it by passing nitric oxide over heated sulphur; by exposing it to muriat of tin; and by bringing it in contact with copper in a solution of ammonia. Upon the conversion of nitric, into nitrous oxide, a diminution of its volume takes place, whether this change be effected by exposing it to the action of any substance whose affinity for oxygene is greater than that of azote for this substance, such as alkaline sulphites, muriat of tin, and dry sulphures; or, whether the metamorphosis be occasioned by the combination of a body "with a portion both of its oxygene and nitrogene, such as hydrogene either in a nascent form or a peculiar state of combination."

* Priestly and Davy, also, Thompson, vide his Chymistry, vol. i. p. 599.

Sulphite of potass converts nitric into nitrous oxide, which possesses all the properties of nitrous oxide obtained by the decomposition of nitrat of ammonia. It effects this conversion with equal readiness, whether it be exposed to the action of light, or deprived of its influence. The sulphites, after this process, are converted into sulphats, which proves that the change depends upon the mere abstraction of a portion of the oxygene of the nitric oxide; the azote and residual oxygene becoming more condensed.

A hundred parts of nitric oxide are converted into forty-eight of nitrous oxide, by exposing it either to the dry muriat of tin, or a solution of it. But the latter does not produce this effect as rapidly as the concrete salt. During this conversion no water is decomposed, nor any azote given out.

Nitric oxide exposed to dry sulphures, is converted into nitrous oxide, by suffering an abstraction of some of its oxygene simply; and it undergoes during the process, a diminution in volume of $\frac{52}{100}$.

When nitric oxide is mingled with sulphurated hydrogene, a slow decomposition takes place. The gasses are diminished, sulphur is deposited, and nitrous oxide generated. In this process, Kirwan and Austin discovered that there was a production of ammonia.

The solutions of the sulphures in water, as of sulphure of strontian or barytes, convert nitric, into nitrous oxide. In this case, the conversion depends

upon the joint effect of the abstraction of oxygene, and the decomposition of the sulphurated hydrogene dissolved in the solution, or disengaged from it. During this process sulphur is deposited and sulphuric acid formed.

In the two following cases, the nitric is converted into nitrous oxide, by the nascent hydrogene. When the first gas is exposed to wetted iron filings, it becomes slowly diminished in volume, and is converted into the nitrous oxide. This process succeeds better in warm than in cold weather, but is not in any wise affected by the influence or absence of light. About twelve parts of the former are converted into five of the latter. In this process ammonia is formed and the iron becomes partially oxidized—hence there is a decomposition of the water by this union of its oxygene with the iron, and its hydrogene with a portion of the oxygene and azote of nitric oxide, to form water and ammonia. Zinc when dry does not act upon nitric oxide; but where a large surface of it is placed in contact with water and exposed to the action of the gas, this latter is slowly converted into nitrous oxide, ammonia is generated, and white oxide of zinc is formed. In this case the water is decomposed by the affinity of part of its oxygene for nitric oxide, and by the affinity of zinc for its oxygene.

It has been supposed that nitric oxide might be changed into nitrous oxide, by passing it with phosphorus through a tube heated to a temperature below ignition.

## OF ITS PRODUCTION

### FROM OTHER SUBSTANCES BY MEANS OF VARIOUS COMBINATIONS AND PROCESSES.

PORTIONS of nitrous oxide are produced by the solution of tin, iron,* copper,† and zinc,‡ in nitric acid diluted with water. But there are combined with it, portions of nitric oxide and azote, differing in proportion, according to the degree of concentration of the acid. In all these cases ammonia is formed; and, of consequence, water decomposed. If the nitric acid be combined with the muriatic or sulphuric acids, the nitrous oxide produced by its decomposition by the metals mentioned, will be increased.

When the tin is dissolved in nitric acid diluted with water,‖ the water is immediately decomposed. Its oxygene converts the metal into an oxide. Part of the acid unites with this oxide, and forms a nitrat

* Dr. Priestly found that hydrogene was sometimes evolved during the solution of iron, in very dilute nitric acid by means of heat. Mr. Davy says he never, in any of his experiments, found this to be the case.

† According to Jacobs.

‡ If the acid be diluted it acts violently upon the zinc, and pure nitrous oxide will be given out; but if highly concentrated, nitric oxide will be evolved.

‖ Concentrated or fuming nitric acid has no action whatever on tin; hence, in this experiment, the acid must of necessity be diluted.

of tin, whilst the hydrogene of the water combines with a part of the azote of the acid and produces ammonia; this is seized by another portion of the nitric acid, and is converted into the nitrat of ammonia; the residual portions of the azote and oxygene of the nitric acid unite, and form the nitric oxide and the nitrous oxide, which pass into the receiver during the process.

When copper is dissolved in diluted nitric acid, a violent action ensues, and a portion of nitrous oxide, combined with nitric oxide is likewise evolved.* The rationale of the process is analagous to that of the preceding. The water is decomposed, its oxygene oxiding the metal, with which oxide a portion of the nitric acid forms nitrat of copper. Ammonia is formed by the union of the hydrogene of the water, and some of the azote of the acid; and this ammonia being seized upon by another portion of the acid, is converted into nitrat of ammonia. The remaining parts of oxygene and azote, form the nitrous and nitric oxide gasses.

If dry nitrat of copper be wrapped up in tin foil, no action whatever takes place; but if water be added, a violent action ensues; a flame is produced; the tin is partly consumed, and the nitrous and nitric oxide gasses are evolved.

I have never heard a satisfactory explanation of the results which take place in this experiment, but will venture to suggest, for want of a better, the following

* Jacobs's Chymistry.

rationale. I believe, however, it will be impossible to prove to a certainty what combinations actually take place in this intricate process. I would suppose that the water is decomposed. The nitric acid of the nitrat of copper is detached, and, of consequence, the copper revived.* Part of this nitric acid is then decomposed. The oxygene of the water unites to the tin, and oxides it; this oxide of tin is seized upon by a portion of the nitric acid that is undecomposed, and nitrat of tin is formed. The hydrogene of the water unites to part of the azote of that portion of the acid that is decomposed, and ammonia is produced: the remaining part of the nitric acid that is undecomposed, unites with this ammonia, and converts it into nitrat of ammonia. The residual portions of oxygene and azote of the decomposed nitric acid, not yet employed, go to form the nitrous and nitric oxides.

If the leaves, bark, or wood of trees, or any other vegetable matters, be dissolved in nitric acid by means of heat, small portions of nitrous oxide, mingled with large quantities of nitric oxide and carbonic acid, are generated.

Small portions of tolerably pure nitrous oxide, are given out upon the decomposition of nitric acid by fixed and volatile oils, alcohol, or ether.

* This I infer also, from the appearance of the tin foil after the experiment, which exhibits a copper colour; this would seem to indicate that the copper was deposited in its metallick form upon it.

When green oxide of iron is dissolved in nitric acid, nitrous oxide, mixed with azote and nitric oxide, is produced.

If diluted nitric acid be added to green sulphat of iron, it will be converted into the red sulphat in consequence of the decomposition of the acid; and nitrous oxide mingled with different proportions of nitric oxide, according to the strength of the acid, will be formed.*

The same thing takes place if the green muriat of iron be employed; this will likewise become red, and during its conversion, the gasses will be produced.

If a solution of green nitrat of iron be exposed to heat, a part of its acid will be decomposed; red nitrat will be formed; red oxide precipitated, and impure nitrous oxide evolved.†

If iron be introduced into a solution of nitrat of copper, a precipitation of the copper in its metallick state will take place, and nitrous oxide mingled with minute portions of azote will be evolved.‡

During the precipitation of copper in its metallick state, by zinc and tin, from its solution in nitric acid, some portions of nitrous oxide mingled with a large quantity of azote, are produced. In all these processes ammonia is formed, and water, of course, decomposed.

* Davy, p. 222. † Davy, ibid. ‡ Davy, ibid.

## PROPERTIES.

NITROUS oxide when carefully prepared, according to the method already specified, possesses all the mechanical properties of common air. It is invisible and elastic, and susceptible of indefinite condensation and dilatation. It is, however, much heavier than atmospherick air, its specifick gravity, according to Mr. Davy, being 0.00197, and bearing the same proportion nearly to it, as does 5 to 3.* One hundred cubick inches of pure nitrous oxide, weigh 50.1 grains, at a temperature of 50°, and atmospherick pressure 37°.† It belongs to the class of oxide supporters, and is one of the six compound supporters of combustion. Combustibles burn in it better than in common air, though not quite so well as in oxygene gas; but no body, however low the temperature at which it takes fire, will become inflamed in this air, unless it be ignited previously to its introduction into it. A tallow candle, or wax taper burns in it with a beautifully brilliant flame and crackling noise, and before it is extinguished the white inner flame becomes surrounded with an exterior blue one.‡ Sulphur introduced into an atmos-

* Davy, p. 94. † Davy, p. 95.

‡ "This double flame arises from some of the vapour of the nitrous acid being seized with the nitrous oxide, for it can be formed by plunging a taper in atmospherick air, containing nitrous acid vapour, or into a mixture of nitrous oxide and azotic gas, through which the nitrous acid vapour is made to pass." Woodhouse's edition of Chaptall's Chymistry, Vol. I page 179.

phere of this gas, in a state of feeble inflammation, will be immediately extinguished; but if immersed in it in a highly ignited state, that is, whilst forming sulphuric acid, it burns with an increased and dazzling brilliancy, and with a beautiful rose coloured flame. Ignited charcoal, deprived of hydrogene, burns in it with much greater vividness than in atmospherick air. Fine iron wire introduced into this gas, in a state of inflammation, burns rapidly and emits scintillating sparks, as in oxygene; the combustion, however, does not continue as long as in that air. Phosphorus burns in this air, if introduced in a state of active inflammation, as it does in oxygene, producing such a brilliant and dazzling light that the eye can scarcely endure its rays. It has an agreeable and peculiar odour, and sweetish taste.* It is absorbable by water, imparting to that fluid, when impregnated with it, a sweetish taste; at the same time that it renders

* M. P. Dispan* observed in this gas an after taste of nitre, but acknowledges that it was the last collected portion of air which he tasted. This accounts for the circumstance. Another gentleman, belonging to the Society of Amateurs of Toulouse, says he perceived in it an astringent quality. He, most probably, had likewise tasted the last portions of gas, which generally contain some nitric acid vapours. All the other members of the society who inhaled the air, declared it to be decidedly sweetish; as, indeed, almost every previous experimenter, who attended to the taste, had before observed. In the account, however, which appeared in the publick prints in this city, of the date of February 25, 1808, of some experiments with this gas, made in New York, under the care of Mr. J. Griscom, Lecturer on Chymistry in that place, no notice is taken of the taste of the gas. This circum-

* *Vide* his communication to the editors of the *Annales de Chimie*. Coxe's Medical Museum, Vol. 4. No. 1. page 54.

it softer and more agreeable to the palate. Pure water saturated with it, gives out, on ebullition, the gas unaltered in any of its properties. It is absorbed by an infusion of blue cabbage, but effects no alteration in its colour, nor that of any other vegetable blues; it therefore does not manifest any actual acid properties. It produces no change of colour in metallick solutions. It is decomposable at a red heat, and by combustible bodies at very high temperatures. It is combinable with the alkalies; but insoluble in most of the acids. "If an acid," says Mr. Davy, "it is the weakest of them." He thinks it a substance completely *sui generis*. It detonates with hydrogene, with a much louder noise than does oxygene. When mixed with oxygene gas or common air, no action ensues; and it undergoes no diminution when mixed with oxygene, or nitric oxide gasses. In contact with oxygene it does not form nitric acid. It renders venous blood exposed to its action of a bright purple colour, and a considerable portion of it is absorbed by the blood.* It is respirable for a limited time, producing exhilaration of spirits, increase of muscular strength, and great agility, unsucceeded by somnolency or languor. When breathed too long, it induces syncope; and, in its most extensive operation, will extinguish life, either in the human or brute animal. It dilates the pupil of the eye. It increases

stance probably owes its origin to inadvertency in the writer of the detail, or in those who inhaled the air, though I cannot well conceive how such a characteristick effect should escape observation.

* Thompson's Chymistry, Vol. 4. page 722, and Davy's Researches.

the pulse in frequency, and somewhat in force. It is, therefore, a stimulus.

When Mr. Davy first respired nitrous oxide, he breathed it only in small quantities, and mingled with common air. In these trials, though not decided in his opinion, he inclined to the idea that it acted as a depressing power. This suspicion received a temporary support from the result of the experiments made by other persons, who, in consequence of their fears were at first unpleasantly affected. Subsequent and satisfactory trials, however, made by numerous persons with the pure gas, entirely exploded this opinion, and it is now proved to be a powerful stimulant, and one entirely *sui generis*. For it does not after excitement increase the debility induced by the excessive stimulation of a known agent, as it obviously ought to do if the reverse were true. This was proved by an experiment of Mr. Davy, who experienced some relief and no languor by inhaling five quarts, while labouring under extreme debility, headach, and nausea, produced by quaffing a bottle of wine in a few moments. He was sensibly relieved of the headach after the third inspiration. Here then debility from intoxication, was not increased in the least degree by the excitement from nitrous oxide. Another proof that this gas is a stimulant of a very peculiar nature, is to be found in the experiment of Mr. Davy, where he enclosed himself in an air-tight breathing box, into which nitrous oxide was thrown in large quantities, and remained there for an hour and a quarter; he experienced no lassitude nor depression. This gas then, unlike other stimulants of vigorous operation, neither induces depression nor

somnolency ; nor does any debility succeed its supreme degree of action compatible with life and the healthy operation of its functionaries. It is a stimulant moreover, not possessed of the least narcotick power; an exception this, to Dr. Crump's* rule, that " that stimulus possesses the greatest narcotick quality, which is highly stimulating, which has this power quickly destroyed, and which is very diffusible." Now nitrous oxide is possessed of all these properties in an eminent degree, and yet is not, in the most minute effect, narcotick.

## ACTION ON WATER.

Dr. Priestly ascertained that nitrous oxide was absorbed very rapidly by water, particularly when agitated with it. It absorbs 0.54 parts of its bulk, or 0.27 of its weight, of this gas, without being perceptibly altered except in imparting to the taste a sense of sweetness. During its absorption by the water, it expels the common air that previously existed in solution in it, and occupies its place; hence when this air is confined with a sufficient quantity of water, a residuum of common air will always be found.† When water saturated with this gas is exposed to the temperature of 312.°, the whole of the gas is again set free unaltered.‡ Water, previously boiled and then saturated with nitrous oxide, gives out when submitted to heat, less air than when unboiled, that

* Crump on Opium.

† Davy, p. 89.

‡ Priestly, vol. ii. p. 81.

is, in proportion as the water is free from air, the expelled residuum is less.

## EFFECTS

### OF THE SIMPLE COMBUSTIBLES ON IT.

SULPHUR has no effect on this gas at the common temperature of the atmosphere, but when introduced into it in a state of inflammation, it burns with increased brilliancy and is consumed. In this case the sulphur combines with the whole of the oxygene, forming sulphuric acid, and the azote remains in a state of gas. When about half of the nitrous oxide is decomposed, the flame of the sulphur is extinguished.*

Phosphorus may be melted and even sublimed in this gas without alteration. It will not burn in it when touched by a wire ignited to a red heat, but if a wire heated to whiteness be brought in contact with it, it immediately burns with a detonating violence. The products are azotic gas, phosphoric and nitric acids, whilst part of the oxide remains undecompounded.† In this case the phosphorus combines with one portion of the oxygene, forming the phosphoric acid; part of the azote unites with another portion, producing nitric acid; the other part of the azote remains in the form of gas, and the residual oxide not employed, is unaltered.

If charcoal confined in this gas be ignited by means of a burning glass, it will burn with a brilliant flame

* Davy, p. 303. † Ibid p. 279.

until about half of the gas is consumed. The products are carbonic acid and azotic gasses. In this case the carbone unites with the oxygene and sets the azotic gas at liberty.*

It detonates violently with hydrogene gas, emitting a red flame when electrick sparks are passed through the mixture, or when a strong heat is applied. If the portions of hydrogene and nitrous oxide be nearly equal, the products will be water and azote; for here the oxygene unites with the hydrogene to form the water, whilst the azote remains; but if there be less hydrogene than oxide, it cannot combine with all of the oxygene, the superabundant oxygene therefore, unites with the azote to produce nitric acid.†

When sulphurated, phosphureted, and carbureted hydrogene gasses are mixed with nitrous oxide, and exposed to the influence of strong heat, they burn, producing different results according to the proportions of the gasses mingled.‡

## COMBINATION

### WITH FLUID INFLAMMABLE BODIES.

NITRIC ether absorbs more of nitrous oxide than water, and gives it out unaltered at the boiling point of this fluid.§

* Davy, p. 311.

† Priestly, vol. ii. p. 83, and Davy, p 286.

‡ Thompson, vol. i. p. 591.

§ Davy, p. 240.

Alcohol dissolves large quantities of nitrous oxide.* The essential oils dissolve more than either of these substances.†

The fixed oils dissolve it at a low temperature.

## COMBINATION WITH ACIDS.

Thompson is of opinion, that muriatic acid has no effect upon this gas,‡ but Davy asserts that this, as well as acetic, and nitro-muriatic acids, absorbs it; the first two about one third of their bulk, and the last a smaller portion.

## COMBINATION WITH GASSES.

Hydrogene detonates with it. The results have been specified. Azote appears to have no particular action on it.§ Nitric oxide mixed with it, does not become nitric acid. Oxygene forms with it, agreeably to some writers, either nitric oxide or nitric acid, according to the proportion added; but this is certainly a mistake; for if a measure of nitrous oxide be thrown into a long glass tube filled with the tincture or infusion of the blue cabbage, and another measure of oxygene gas be added to it, no union will take place, nor will the blue tincture be altered in colour. Hence this gas does not combine with the oxygene, nor produce an acid with it. The experiment I have seen Dr. Woodhouse frequently perform before his

* Davy, p. 242. † Ibid, p. 243.

‡ Chymistry, vol. 1. p. 591. § Thompson, vol. i. p. 591.

class, and have repeated it myself, with precisely the same result.

## COMBINATION WITH ALKALIES.

Mr. Davy discovered that nitrous oxide is capable of combining with alkalies, thereby forming salts of a very peculiar nature. Dr. Thompson proposes to call these salts Azotites, instead of Nitroxis, the name given them by Mr. Davy, because he thinks the term exceptionable, "not only because it is contrary to the idiom of the English language, but because it is inconsistent with the rules laid down for the forming of chymical terms."*

Mr. Davy observes, that when the nitrous oxide comes in contact with the alkalies at the instant of its formation, it readily unites with them and forms these new salts; but that this combination does not take place when the alkalies are exposed to its action in the gaseous state. He endeavoured to combine nitrous oxide with ammonia and the earths, but did not succeed, though he rendered it probable that such a union might possibly be effected.

Azotite of potass† is obtained in irregular crystals. It is composed of about three parts of alkali, and one part of nitrous oxide. It is soluble in water. Its

* Vide his Chymistry, vol. i. p. 592.

† For an account of the process by which it is formed, vide, Davy's Researches.

taste is caustick, and it has a peculiar pungency. It converts vegetable blues into green. Pulverized charcoal mixed with it, and inflamed, burns in it with slight scintillations. When projected into zinc, in fusion, a slight inflammation takes place. All acids, even carbonic, seem capable of expelling the nitrous oxide from potass.* The other properties of this salt have not been examined.†

Azotite of soda‡ nearly agrees in its properties with azotite of potass. The nitrous oxide is disengaged from it by a heat of between 400° and 500°. Its taste is more acrid than that of azotite of potass, and seems to contain less oxide of azote.‖

## TESTS OF ITS PURITY.

THE best tests of the purity of this gas for respiration, and at the same time the easiest to be employed, are the following:

1. Sulphur, when introduced into pure nitrous oxide, burning with a blue flame, is immediately extinguished; but if it be introduced in a state of high ignition, it burns with a rose coloured flame and dazzling brilliancy.

* Davy, page 262.

† Thompson, article oxide of azote.

‡ For the mode of making it, vide Davy's Researches.

‖ Davy, p. 268, and Thompson, article oxide of azote.

2. A lighted candle when placed in pure nitrous oxide, will burn with a crackling noise and brilliant flame.

3. Red hot charcoal, or iron, will burn in it, when pure, with increased brilliancy.

## COMPOSITION.

FROM the account of the properties of this gas, that we have in the preceding pages given, it is manifest that, as it is capable of supporting combustion, it must contain oxygene in the same state in which it exists in other supporters. The evolution of either azote or nitric acid, upon the decomposition of nitrous oxide, is a fact demonstrating that azote is the other component part.

These two substances, therefore, compose nitrous oxide, in the proportion of 7 parts, by weight, of oxygene, to 12 of azote; or nearly, 63 parts azote to 37 oxygene = 100.

This statement, which Mr. Davy has proved to be correct, contradicts an opinion, advanced by an anonymous writer,* that the effects of nitrous oxide "intimated what would be little expected, that it contained a large portion of *hydrogene*." Nitrous oxide is, therefore, an oxide of azote; now the oxidizement of azote takes place in three different proportions, producing nitrous oxide, nitric oxide, and

* Tilloch's Philosophical Magazine, Vol. 6. page 95.

nitric acid. The first is the base of nitrous gas; the second is fuming nitrous acid; the third, white nitric acid. The exact proportions of oxygene contained in each of these compounds of azote, according to the experiments and calculations of Mr. Davy, are as follow:

| Azote. | Oxygene | |
|---|---|---|
| 100 | 58 7 | Nitrous Oxide. |
| 100 | 132.5 | Nitric Oxide. |
| 100 | 239.9 | Nitric Acid. |

And from these proportions the following deductions are made:

58.7 is the oxygene in nitrous oxide, which subtracted from 132.5 the oxygene in nitric oxide, leaves 0.738, the excess of oxygene in nitric oxide above that in nitrous oxide; and 132.5 the oxygene in nitric oxide, subtracted from 239.9 the oxygene in nitric acid, gives us 1.074, which is the excess of oxygene in nitric acid above that in nitric oxide; therefore:

| Azote. | Oxygene. | Nitrous Oxide. | Oxygene. | Nitric Oxide. | Oxygene. | Nitric Acid. |
|---|---|---|---|---|---|---|
| 1.00 | + 0.587 | = 1.587 | | | | |
| | | 1.587 | + 0.738 | = 2.325 | | |
| | | | | 2.325 | + 1.074 | = 3.399* |

Dr. Thompson is of opinion that if the investigation of this subject be pursued, it will "throw much light on the nature of combustion, an operation

* Thompson's Chymistry, Vol. I. page 601.

much more intimately connected," he thinks, " with azote and its compounds, than is at present supposed."* To this opinion I subscribe without reservation, since I cannot believe that azote, as Lavoisier supposed,† is entirely passive in combustion; for if this supposition be true, how can we account for the difference in the combustion of a taper in oxygene gas and atmospherick air?

## DECOMPOSITION BY COMBUSTIBLES.

BEFORE speaking of the decomposition of this gas, by combustibles, it may not be improper to remark, that light, even when its rays are concentrated by means of a reflecting mirrour, effects no alteration in the nature of it; nor is it affected by any temperature below ignition.

Reiterated electrical shocks resolve this gas into an air analogous to atmospherick air, and nitrous acid. The Dutch chymists knew that common air was produced, during this decomposition, but Mr. Davy was the first person who discovered that nitrous acid was also generated.‡

Nitrous oxide is decomposable, at the temperature of ignition, by hydrogene, in a variety of proportions. The results are different, according to the quantities employed. Sometimes only water and azote are pro-

* Thompson's Chymistry, Vol. I. page 601.

† Elements of Chymistry, chap. 8. ‡ Researches, p. 281.

duced; at other times water, nitric oxide, oxygene, and azote are found remaining.*

Phosphorus may be inflamed in pure nitrous oxide without undergoing acidification; or it may, according to the temperature, be oxygenated in two different degrees, so as to produce phosphorous acid and phosphoric acid. Phosphoric vapour detonates with nitrous oxide, with a loud noise.†

Phosphorated hydrogene decomposes nitrous oxide at the temperature of ignition.‡

Sulphur decomposes this gas. The results are, azote, sulphureous and sulphuric acids.

Sulphurated hydrogene and nitrous oxide, when mingled together in certain proportions, and ignited by the electrick spark, undergo mutual decomposition.‖

Ignited charcoal decomposes this gas; the results are carbonic acid and azote.

Hydro-carbonate decomposes nitrous oxide, when mixed with it in certain proportions, and exposed to the action of the electrick sparks. The results are carbonic acid and azotic gas; there is no free evolution of hydrogene perceived, and no precipitation of charcoal takes place.§

* Researches, page 290. † Davy, page 295.

‡ Ibid, page 300. ‖ Ibid, page 306. § Ibid, page 315

Iron, inflamed in this gas, decomposes it.

Pyrophorus inflamed in it by a temperature above 212° decomposes it; and a very small portion of carbonic acid is produced.

When the gasses remaining after a taper has burnt out in nitrous oxide, are examined, they are found to be composed of carbonic acid, azote, and about one fourth of undecompounded nitrous oxide, and much nitrous acid is suspended in them.

Compound combustible bodies, burn in and decompose nitrous oxide at very high temperatures. During the combustion of wood, cotton, and paper in this gas, (all which may be inflamed in it with a burning lens) nitrous acid is formed, carbonic acid and water generated, and azote produced.

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## SECTION SECOND.

## RESPIRATION OF NITROUS OXIDE.

DR. PRIESTLY concluded that this gas was unfit for respiration;* but, except in one instance,

* The term respiration has had different meanings affixed to it. Some contend that when we speak of a gas as respirable, we assign to it the property of supporting life. In this sense of the word, nitrous oxide is decidedly a non-respirable gas. Others have thought proper to apply this term to any air that could be taken into the lungs, and for a definite period answer the purposes of respiration. Wherever I have

†the gas with which he experimented, must have been extremely impure, and contained probably more than thirty-seven parts of oxygene to the hundred, in its composition, in which case the air would have been nearly allied to nitric oxide which is not respirable. I am the more inclined to this suspicion, from having witnessed the following circumstance on the first day of the experiments made in January 1807, in this city. A number of young gentlemen, whilst breathing what they deemed pure nitrous oxide, from glass jars furnished with long tubes and stop-cocks, and inverted over water in a pneumatick tub, instead of being affected with the pleasant sensations they expected to experience, were seized with giddiness and somewhat of pain in the head, a sense of suffocation, violent fits of coughing and inclination to faint. I was affected in this manner myself upon respiring some of it, and from the experiments I afterwards made with pure nitrous oxide, am disposed to suspect that the jars either contained an air having some acid vapour suspended in it, or that the heat applied in generating

used the word respirable in these pages, I would be understood to adopt the latter meaning: viz. the capability of a gas, as nitrous oxide, of being taken into the lungs by voluntary efforts of the respiratory organs, and for a limited time serving the end of respiration, without any reference whatever, to its vitality.

† The experiment alluded to, is that wherein he found that a mouse confined in an atmosphere of this gas, breathed it four minutes without any inconvenience, or at least without discovering any signs of oppression or uneasiness.

the gas had been so great,* that nitric oxide and azotic gas were produced, which taken into the lungs, stimulated them so as to induce the coughing, &c. That the gas was rendered impure by this or some other means, I am perfectly convinced; for instead of the eagerness with which I have since inhaled nitrous oxide, every inspiration then became more difficult, and the sense of suffocation greater.

The Dutch chymists who examined this gas, after Dr. Priestly, corroborate his opinion as to its incapability of supporting respiration at all: they, however, had doubtless fallen into the same errour from having experimented with a similar, and equally impure agent—for though it is much less respirable than oxygene gas or common air,† yet it has been satisfactorily ascertained by the experiments of Mr. Davy,‡ and confirmed by those of a more recent date, that it may be breathed in large quantities§ for a few minutes, not exceeding five, without inducing any other effects than those of the most exhilarating kind resembling inebriation, with this difference, that the languor and nausea which always supervene upon intoxication do not follow the elevating effects of this gas. When breathed for a longer time than

* This was the case only in the first portions of gas that were made, which were contained in three of the jars; the rest was perfectly pure, since it produced the usual exhilarating effects upon those who inhaled it.

† Davy, p. 94. ‡ Vide Researches.

§ Mr. Davy inhaled twenty quarts at a time—he was accustomed to respire it after long journies and great fatigue, with the effect of invigorating his system.

five or six minutes, all voluntary motion ceases, and either faintness or deliquium ensues. Animals confined in this gas breathe for some moments without difficulty, then become restless and jump about, and if continued longer than from four to five or six minutes in it, die; for, having consumed all the oxygene, they are exposed to an atmosphere of azotic gas.

## MODE

### OF RESPIRING IT.

Nitrous oxide, especially that prepared from fibrous nitrat of ammonia, should not be inhaled immediately after it is made; because it then is apt to contain some acid vapour suspended in it, which produces a disagreeable sensation in the fauces, and stimulates the lungs so as to induce coughing. After it has stood some time, then it is to be conveyed, by means of the airholders, into large bladders furnished with stop-cocks, and after making a full and voluntary expiration, and closing the nostrils, a deep inspiration is to be made from the bladders; this volume of gas thus taken into the lungs, is to be again expelled from them into the bladder, and inspirations and expirations are to be made alternately, until the effects of the gas are perceived. That a complete voluntary exhaustion of the lungs is absolutely necessary to enable the gas to exert its operation I infer, from the fact, that even after their entire exhaustion, so far as lies in our power, a very considerable volume of air still remains in them;* and that this air would

* The air contained in the lungs, after a complete expiration, is variously estimated by different writers on the

dilute the nitrous oxide is obviously true. We are told that Mr. Davy, after a complete voluntary expulsion of the air from his lungs, was almost unable to breathe hydrogene gas for only half a minute. It produced uneasy feelings in the chest, momentary loss of muscular power, and sometimes a transient giddiness—but when he did not previously empty his lungs, he was able to breathe it for about a mi-

subject. According to Goodwin's experiments, it amounts to 109 cubick inches;* Menzies adopts this computation. Davy, however, concludes from his experiments, that the capacity of the lungs after a complete expiration,† is much less considerable than Goodwin and Menzies suppose; but Dr. Bostock has rendered it probable, that there was some fallacy in his experiments, since his computation is so widely different from the calculation of others, and so inconsistent with the anatomical structure of the thorax. He supposes that the hydrogene employed by Davy, was not diffused uniformly, through all the air-cells of the lungs.‡ Coleman has also estimated the capacity of the lungs§ too inconsiderably, and it seems probable that he fell into this errour from supposing their capacity after drowning to be equal to their compass after a complete expiration in health. Dr. Bostock says, that Goodwin's estimate is the nearest approximation to truth, though not quite correct.|| This then being the case, the nitrous oxide would become diluted in consequence of mingling with this large portion of air, before it could produce any effect.

* On Respiration, &c. sec. 3, p. 23. † Researches, p. 409.

‡ Bostock on Respiration, chap. 3, p. 25.

§ Observations on the state of the lungs after drowning, p. 91.

|| On Respiration, p. 35.

nute, without much inconvenience.* In this last case then, it is manifest, that the hydrogene gas was rendered less powerful by its union with the contained air of the lungs, thereby becoming so much diluted as scarcely to produce any effect. The method of breathing the gas from a jar inverted over water, is extremely improper. The reasons are obvious, and by no means inconsequent:—first, we have already said that it combines readily with water when agitated with it, and that a portion of common air, then dissolved in the water, was evolved, and occupied the place of the nitrous oxide; now the frequent inspirations and expirations that are made while breathing the gas, have a tendency to effect this agitation. Hence a portion of it will be absorbed by the water and will displace the common air formerly dissolved in it. Of consequence the nitrous oxide that remains unabsorbed by the water, will be diluted by this residuum of atmospherick air. Secondly, at each inspiration, the person breathing is necessitated to raise a column of water equal in dimensions to the capacity of the jar—This requires a considerable exertion, and induces a sense of suffocation, and great oppression at the breast, which renders the experimenter unwilling to repeat the trial. Now, the water being a dense fluid, and its particles in a state of cohesion, it will occasion much resistance. Therefore, upon expiring the air thus received into the lungs, another exertion of force is necessary to displace the water, that has arisen perhaps to the top of the jar, and so on with each succeeding inspiration and expiration.

* Davy, p. 400.

The great anxiety attending this method of introducing the gas into, and expelling it from the lungs, seldom encourages the inhaler to continue his trial for a sufficient length of time for it to operate; added to which, the gas by dilution is rendered so inert, as to be incapable of inducing any uncommon effect. No wonder then, that when inhaled in this manner, it so often fails to produce the exhilaration and other extraordinary effects, which under different, and more propitious circumstances, always succeed the breathing of it. When the breathing bag, or bladder is employed, the inspirations are assisted by reason of the pressure of the surrounding air on it, and when the gas is to be expelled from the lungs, the person expiring it has to overcome the resistance of a much lighter fluid, whose particles are not in contact.* From this statement the conclusion is

* I conceive that the motion of the expired air, produced by the force of an act of expiration, in the glass jar displacing the water therein, and into the breathing bladder removing the surrounding atmosphere, is exactly similar to the motion of a body immersed in a fluid, and is therefore subject to the same laws that regulate the resistance which fluids make to bodies moving in them. Thus, " when a body is immersed in a mass or quantity of fluid matter, and is in motion, it must separate the parts of the fluid from each other as it moves. If the parts of the fluid be without cohesion or tenacity, this separation will be attended with no difficulty; but if the tenacity be considerable, it will require a considerable force to overcome it. A part of the motion must therefore be lost in producing this effect."* Now the motion of the air expired into the bladder through the surrounding atmosphere I conceive to be a body moving through a fluid; and the parts of this fluid are without cohesion or tenacity: of consequence the

* Nicholson's Philosophy, book ii. sec. 3. chap. iv.

plain, that the latter is the preferable mode of respiring the gas, and ought always to be pursued when practicable. If however, at any time the breathing jar should necessarily be employed, the inhaler ought carefully to expire all the air from his lungs, and continue to breathe the gas without admitting a particle of air, either through his nostrils or by opening his mouth, which, from the difficulty of breathing he will feel a frequent inclination to do.

## PHENOMENA

### SUPERVENING UPON THE RESPIRATION OF IT.

WHEN this gas is inspired, it passes through the glottis without stimulating it, but affects the trachea, and bronchiæ with a sensation perfectly *unique*. I am acquainted with no analogous feeling to which

moving body, (i. e. the air forced into the bladder from the lungs) will separate its parts, or in other words, displace the surrounding air, without difficulty. On the contrary, the motion of the expired air in the glass jar containing water which I likewise conceive to be a body moving in a fluid, must be attended with considerable difficulty ; since the parts of the water are not easily separable by reason of their cohesion or tenacity, which is considerable, compared with atmospherick air, whose parts have no coherence. Again, " in like circumstances, the resistances of fluids are as their densities."† Hence the resistance made by the surrounding atmosphere to the expired air in the bladder moving through it, will be infinitely less considerable than that opposed by the water in the glass jar to the air expired in it; since the densities of the two fluids are unequal, that of water being very considerable compared with the density of air.

† Nicholson's Philosophy, book ii. sec. 3. chap. iv.

I can compare it, though I might say, it seems to be produced by something slightly astringent. The alæ narium become distended, and remain so as long as the gas is respired. The face becomes flushed; the eyes are widely opened, exhibiting a wild, glassy, and penetrating lustre; the pupil is, always dilated, so much so at times, as to be alarming, † and an extravasation of blood into the minute superficial vessels of the tunica adnata takes place, thereby rendering them red, and giving to the eyes an appearance resembling that exhibited in slight opthalmia. This redness continues generally for the space of thirty or forty minutes after all other effects of the gas have gone off. A thrilling or tingling sensation is experienced in the extremities of the fingers and toes especially, but sometimes pervading the whole body; also a sense of dilatation and great heat, or gentle glow in the chest, vivid exhilaration, increased muscular energy and action, involuntary speech, laughter and gesture, and great pride and indignation (if violently affected) upon recovering from this semi-delirious paroxysm.

† This effect of the gas which always indicates a febrile state of the head, has not been observed by any writer on this subject before; and yet I have found it a decided and universal symptom of its operation. I observed it to take place in one of the persons who breathed the gas in the month of January 1807, and mentioned the circumstance a day or two after to Dr. Woodhouse, who informed me he had never remarked it. I was however, decidedly convinced in my own mind, that it would always occur. Since then I have paid much attention to the appearance of the eyes while the experimenters were affected with the gas, and can confidently assert, that this dilatation is always produced in a greater or less degree, when there is any considerable exhilaration, or other unequivocal effect of its operation.

The sensations sometimes produced, under peculiar circumstances, are quite unanalogous to any ever before experienced, and are therefore indescribable. This is remarkably evinced by the answers of the two paralytick patients, mentioned by Mr. Davy. When questioned, after they had inhaled the gas, as to how they felt during its operation; they replied, the one "I do not know how, but very queer;" the other, "I felt like the sound of a harp." A gentleman, who had inhaled the air, being a lover of musick, compared his sensations to those once experienced in Westminster Abbey, whilst listening to the grand choruses in the Messiah, produced by the united powers of seven hundred instruments of musick. I would compare the sublime emotions of the mind and bodily pleasure, which are sometimes produced by the gas, to those sensations which we experience from the contemplation of the beauty and grandeur of the works of nature. Bruce elegantly describes these feelings as produced in him by viewing the cataract of the Nile; and Brydone upon surveying the burning of mount Ætna, which illuminated the Mediterranean for one hundred miles in extent. But this sublime elevation of mind, this vital feeling of body, is most expressively delineated by the Abbe Spallanzani, when describing his bodily sensations, and the state of his mind upon the summit of mount Ætna.*

Its general effects upon the system, I would, with some few exceptions, compare to those directly produced by wine or opium. These effects we will

* Vide his Travels into the two Sicilies, vol. i. p. 284.

point out as coinciding or disagreeing with those of a paroxysm of ebrietas, as described by Dr. Darwin* in the following words: "By the stimulus of wine or opium, the whole arterial system, as well as every other part of the moving system, is excited into increased action. All the secretions, and with them the production of sensorial power itself, in the brain, seem to be for a time increased, with an additional quantity of heat, and of pleasurable sensation." Thus, by the stimulus of nitrous oxide, upon the lungs primarily, and secondarily through the medium of the brain, "the whole arterial system,† as well as every other part of the moving system, is excited into increased action." This I infer, first, from the state of

* Zoonomia, Vol. I. page 16.

† It was supposed by Dr. Beddoes, that this gas had no sensible operation upon the arterial system. He generally felt during his experiments, a glow in his cheeks; but, when he applied his hand to them, he never found their temperature increased, nor his face flushed. Hence he concluded, that there was at such times, an increase of nervous energy only, and not of arterial action. This opinion I cannot subscribe to. The state of the pulse, and violent throbbings in the temporal and fascial arteries, being, I think, sufficient proofs of its fallacy. From the Doctor's idea on this subject, he did not hesitate to administer the nitrous oxide to a paralytick patient, whose pulse indicated a highly inflammatory diathesis in the system. I cannot, in this place, silently pretermit what I must deem the impropriety and dangerous tendency of this position, without remarking—that it certainly would have been the more rational, as well as the safer practice, to have bled this patient, until her pulse should have been sufficiently reduced to remove all apprehension of an effusion of blood into the ventricles of the brain, a consequence which might naturally succeed such violently stimulating effects as

the pulse, which is universally accelerated by its operation; and, secondly, by the increased muscular energy and bodily activity, always consequent to the introduction of this air into the lungs. It also stimulates the secerning system in some degree, though "an increase of all its secretions," is by no means a consequence of its operation. That it does so I infer, from an evident augmentation of the quantity of some of the secretions; thus, I have constantly observed an increase of perspiration; in most instances an augmented secretion of tears; and sometimes, though rarely, of saliva, to supervene upon the respiration of this gas.

There is likewise "an increased production of sensorial power itself in the brain," or, in other words, the brain is in a state of increased excitement, "with additional quantity of heat and pleasurable sensation."

There are, however, two effects of the nitrous oxide, where our analogy to a fit of intoxication, and its indirect effects, fails; to wit, the shortness of the paroxysm (if I may use the expression) of the former,

those induced by nitrous oxide. It is true no injury resulted, and the propriety of the practice in that particular instance, was proved by the issue; but it is equally true, that a dissimilar and less fortunate termination might, very possibly have taken place, and ought justly to have been dreaded. From the effects of this gas, experienced by myself, I would not answer that congestion in the brain, or even apoplexy itself, would not be the consequence of inhaling a large quantity of it pure, in such a state of the system as is indicated by a strong inflammatory pulse, beating one hundred and four strokes in a minute.

compared to the long duration of the fit in the latter; the one seldom exceeding a period longer than five minutes, the other often continuing for the space of five or six hours;—also, the extremely debilitated and languid state of the system supervening, after the immediate effects of inebriety have gone off; whilst on the contrary, it is in a state of high excitement for some hours after the operation of the latter has ceased; for, except in one or two instances, we have not known the least lassitude or debility to ensue, after the more violent effects had subsided, nor any, the slightest, depression of spirits to succeed their unusual and extraordinary elevation.

It is true that in some persons who have made a trial of this air, with every necessary precaution, and according to the directions already specified, it has failed to produce these effects; and, in consequence of such failure, in these individual instances, which must be owing to something accidental, because the general result is widely dissimilar, it has been argued that the effects ascribed to this gas originated in the imagination. This, however, is not a sound argument, but a *fallacia accidentis*, and those who have advanced it, instead of drawing inferences by logical ratiocination, reason sophistically; for we cannot pronounce concerning the *nature and essential properties* of any subject according to something which is merely accidental to it. It would, we apprehend, be better reasoning in the present instance, to conclude, (knowing the general result to be different) that this failure was not owing to any inertness of the gas, nor to any inability in the lungs of such persons to be acted on by it, but entirely to the insufficiency of the

quantity employed, a much larger dose being requisite to affect such persons, owing to some peculiarity of temperament, or constitution of body. We know that ipecacuanha, in two very unequal doses, will induce emesis in two different persons of dissimilar habits of body; and, because this effect is, in most adult systems, procured by ten or fifteen grains, and other persons, from some idiosyncrasy of constitution, are not affected by twice or perhaps thrice that quantity; could any one infer, rationally, that ipecacuanha is not deservedly ranked as an article of the class of emetica? Or, because one man is inebriated by three or four glasses of wine, whilst another can quaff as many bottles of the same liquor with impunity, would any rational person deny on such grounds, the intoxicating quality of this exhilarating juice? This would be reasoning indeed, *á dicto secundum quid ad dictum simpliciter*. We cannot argue from that which is true, in *particular circumstances*, to prove the same thing true, *absolutely*, *simply*, *and abstracted from all circumstances*. Therefore granting (argumenti causa) that no quantity of this air, however great, introduced into the lungs of some persons, can in any wise affect them, this in no way militates against the fact, that it does, *generally*, exhilarate persons not rendered unsusceptible of its powers by idiosyncrasy of constitution, or any peculiarity of temperament or habit.

As a corollary to all this, therefore, it follows: that notwithstanding nitrous oxide has in *particular individuals* failed to produce the effects ascribed to it, though they have properly respired it, yet *generally*, and independently of idiosyncrasies and ex-

traneous circumstances, it possesses the power of inducing great and peculiar hilarity, novel sensations and ideas, increased and involuntary muscular motion, gigantick strength, and extatick pleasure; and we have a right to reject all contrary opinions as to its effects, founded upon the anomalous results of particular and peculiar experiments, as erroneous, inconclusive, and inconsequent: for that which is true by accident in a particular instance, or under peculiar circumstances, does not disprove the reality of a general principle; and we cannot logically, deduce general conclusions from partial or particular premises.

## CHANGES

### EFFECTED IN IT BY RESPIRATION.

The changes effected by respiration in this gas, are at different times a little varied; but this variation is generally in the quantity, and not in the nature of the different residual gasses. In all the experiments, however, that have been made, a considerable absorption of the nitrous oxide takes place. The following is the result of Mr. Davy's analysis of the air remaining after respiring 102 cubick inches of nitrous oxide containing one-fiftieth of common air. Forty cubick inches of it were absorbed, the remaining sixty-two cubick inches were analysed, and found to consist of

| | |
|---|---|
| Carbonic acid - - - - - | 3,2 |
| Nitrous oxide - - - - - | 29,0 |
| Oxygene - - - - - - | 4,1 |
| Azote - - - - - - - | 25,7 |

In this experiment therefore, 71 cubick inches of nitrous oxide had disappeared. Mr. Davy found that azote was generated during this absorption of air by the lungs, and he thought that its production was increased in proportion as the blood became more fully impregnated with nitrous oxide. He was not of opinion, however, that this formation of azote was owing to the decomposition of nitrous oxide in its aëriform state immediately in the lungs, in consequence of the affinity of the red particles of venous blood for its oxygene, and their attraction of it; but supposes rather, that it was the consequence of a "new arrangement produced in the principles of the impregnated blood, during circulation; from which, becoming supersaturated with azote, it gives it out through the moist coats of the vessels."* I cannot help dissenting from this opinion, relative to the non-decomposition of nitrous oxide during its absorption by the blood. For I believe that the affinity of the red globules of the blood for oxygene, is so strong, that they will unite with it in whatever state of combination it is exposed to their action, all other affinities it may have for other substances in that combination, notwithstanding.

* Researches, p. 416.

## SECTION THIRD.

## EFFECTS UPON MR. DAVY AND OTHERS.

NITROUS oxide had, as we have said before, been considered by Dr. Priestly and the Dutch chymists, as wholly unfit for respiration. Mr. Davy was the first person who proved this opinion unfounded.

He first breathed a quart or two of impure nitrous oxide, prepared from the nitrous solution of zinc, mingled with more than equal parts of oxygene or common air. He found that it induced depression and a tendency to syncope, and that the pulse was rendered slower during its operation. Disbelieving in the hypothesis of Dr. Mitchell, relative to contagion, and judging that it produced no immediate action on the irritible fibre,* nor any effects tending to the destruction or injury of animal life, he boldly essayed its respirable properties in a state of supreme purity. He fortunately for himself, and still more happily for chymical science, did not meet with the fate of the rash and venturous Palatier de Rosier,† but found that he could breathe it for any time not exceeding five minutes, not only without injury, but with sensations of the most exquisite pleasure. His thoughts were sublime and totally unlike any he

* This suspicion was verified by subsequent experiments; for he found that the application of the gas to a wound produced no effect.

† Vide Jour. de Phys. 28, 425.

had ever before experienced. He seemed wholly occupied by ideal existence, and declared during his paroxysm of mental delight, "*nothing exists but thoughts! the universe is composed of impressions, ideas,* pleasures and pains!*"

He found that a dose or two, removed slight headachs, and in one instance it relieved him immediately of a headach from indigestion, though it returned, but with much less violence than before. He found that it removed intense physical pain, as it relieved him from the dreadful and alarming situation into which he was thrown by breathing four quarts of hydro-carbonate. He mentions that cardialgia, eructations, and unpleasant fulness of the head, have been produced by inhaling it while labouring under indigestion. When he breathed it amidst noise, his sense of hearing was painfully affected, even by moderate intensity of sound, and after an experiment, he found the light of the sun to be disagreeably dazzling. He once or twice felt, whilst breathing it, an uneasy sensation of tension in his cheeks, and transient pains in his teeth. Such was his fond-

* One would suppose that Dr. Berkley had been under the operation of this gas, when he told the world that he believed all our senses, and all external objects, even our bodies, had no real existence, but were all the effects of delusions; and that ideas were the only things which existed in the world. Would that we could uphold so good an excuse for the absurdities advanced in this visionary hypothesis, only surpassed by the preposterous chimera of a Hume, who, as if anxious to approach the *ne plus ultra* of human irrationality, denied the existence both of matter and spirit.

ness for this air, that a desire of breathing it, he says, was produced in him by the sight of a person inhaling it, or even by looking at a breathing-bag.

Numberless unequivocal experiments, corroborative of those detailed by Mr. Davy, are to be found in his "Researches," Nicholson's Phil. Journal,* Tilloch's Phil. Mag. † &c. Some experiments were performed by a Society of Amateurs at Toulouse, a detail of which was communicated to the editors of the *Annales de Chimie*, by M. P. Dispan, professor of chymistry in that city.‡ These experiments corroborate those of Davy and others; though the gas employed induced fainting in some instances. This is often the case when the dose is over proportioned to the strength of the inhaler. The experiments which were performed in Philadelphia last winter, to be detailed presently, together with those recently made in the city of New York under the direction of Mr. J. Griscom, lecturer on chymistry, are other proofs, if indeed additional evidence be necessary, of the reality of the sensations described as the effects of the air. This, however, we now deem to be beyond all contest, unquestionably decided.

It appears from the accounts of Dr. Beddoes, that this air induced hysteria and syncope, in females predisposed to these affections. It produced such a violent

* For May and December, 1799. † Vol. 10, p. 86.

‡ These experiments have been republished in Coxe's Medical Museum, vol. iv. No. 1. p. liv.

and continued hysterical affection in a young lady of delicate habit, and nervous temperament, that it was found necessary to administer the bark and opium in large quantities, for the space of a week, before she entirely recovered.* It will therefore always prove a precarious, if not an injurious practice, to administer the nitrous oxide to females of nervous or hysterical predispositions, unless in very small quantities, and never undiluted.

I shall now proceed to give an account of the feelings I have myself experienced, upon respiring this gas. It may not be impertinent to the subject to remark, that the sensations I have described, are not the visionary offspring of a creative brain. So far from being conjured up from the effervescence of fancy, they fall far short of the truth, I believe, in the idea they convey of the pleasurable elevation of mind I have experienced. Indeed, the common expressions by which we disignate known feelings or sensations, are but feeble and inadequate vehicles to convey a just conception of such as we have felt upon respiring this gas; and we may say of the pleasures of the nitrous oxide, as Dr. Rush has fancifully though emphatically observed of the pleasures of the moral faculty: "It would require a pen, made of a quill, plucked from an angel's wing, to describe half the pleasures arising from this source."† As a simple perception cannot be defined, but must be referred to experience, so these feelings are incapable of correct deline-

* Vide Beddoes' Notice.

† MSS. Lectures, Lecture on the pleasures of the senses and the mind.

ation, and can only be understood by being referred to experiment; for they, like all original sensations, admit of no conception from description, but must be felt to be known; no analogous feelings having previously existed to which they can be compared. The only method by which we can arrive at any accuracy in the description of peculiar and novel sensations, is by employing such language as will best convey an idea of those feelings which are most nearly allied to them. It is in this manner I have endeavoured to paint the particular sensations the gas produced upon me, and though the colouring may be deemed too glowing, yet I can confidently assert that the sensations there described, are not the accidental touches of a creative brush, but the chaste colouring of a correct and original outline. It is, however, sometimes necessary to caricature, in order to render a likeness striking; and this may be done without losing sight of the peculiar turn which constitutes the trait we wish to imprint. I again aver, that the sensations of which I shall presently give an account, are not the workings of "fancy's witchcraft," but the unsophisticated delineations of the most delightful feelings, which will in others, who make the trial, cæteris paribus, never fail to supervene upon the proper introduction of this air into the lungs, in sufficiently large doses.

In January 1807, I first inhaled pure nitrous oxide. I breathed six quarts of it from a bladder.* The

* This and the succeeding experiment, are those related by Dr. Woodhouse, in his edition of Chaptall's Chymistry (Vol. I. p. 182.) I may, not improperly remark, that the rage he notices, must have been occasioned by the frequent

first inspiration, by which I took about a quart of the air into my lungs, produced no unusual effects on them, owing, I suppose, to its union with the air contained therein. The second, by which I inhaled the whole volume of air contained in the breathing bag, was attended with slight giddiness, and a kind of tranquil pleasurable sensation, accompanied with an impatient eagerness to expel the air from my lungs that I might again experience the same feelings by a new inspiration; this eagerness I manifested by a violent expiration, "that seemed," to use the emphatick words of a by-stander, "as if it would have blown the bladder through." During both these inspirations I was perfectly sensible of my situation, and of my object in breathing from the bladder. When I inhaled the gas a third time, it imparted a saccharine taste, like that of fine cider; my vision became suddenly obscured, so that I had not a distinct perception of the nearest objects. I again felt the same pleasant sensation, previously experienced, with the difference of its being less tranquil. This continued till it produced a pleasurable elixity†

attempts he made to remove the bladder from my mouth while I was breathing; though, at the time, I was only conscious of some intruding power exerting itself to deprive me of my pleasure. In both these experiments, I experienced the most extatical delight, with the exception of this little interruption. The sensations were particularized, in the language in which they now appear, immediately upon my return from the laboratory.

† I use this word upon the authority of Miss Owenson, who, I believe, coined it; and has, I think, employed it with peculiar elegance and expression in her "Wild Irish Girl."

I never before experienced, and of which no words can convey a just idea; but, like all original sensations, it must be experienced to be known. I was affected with a tinnitus aurium, which I well recollect to have continued as long as I was sensible of my situation. A glow was diffused throughout my lungs, and at the same time they were affected with a thrilling or titillating sensation, that afterwards extended itself through every part of my frame; but dwelt longest on the extremities. This sensation, as it respects its effects on the lungs, very much resembles the thrilling or actual vibration* induced by the

As she is, particularly with the fair sex, a very popular authoress, I hope, in its adoption, I shall be justified. It conveys, to my mind, an inexpressibly happy concordance of airy activity of body and mental hilarity, which no other word can designate. The idea it imparts to me, will be better understood when I cite the passage in which it appears. It is where Glorvina, with that modesty which true merit always discovers, entreats in vain her preceptor, Father John, not to exhibit a little effusion of her genius to Mortimer. After using every entreaty to gain her purpose, without effect, she at last snatched the *morceau*, and "flew away like lightning, laughing heartily at her triumph, in all the *elixity* and playfulness of a youthful spirit." Letter VIII.

* A "vibration in the lungs," produced by sound, since it is entirely a mechanical impulse or affection, may seem to be an improper mode of expression; but, that different parts of the body may be thus mechanically affected, by certain monotonous sounds and musical tones, I am decidedly of opinion. As the effect of the former, I have myself experienced it, by means of the horn alluded to; and as a consequence of the latter, have voluptuously felt and enjoyed it, while listening to the soul touching tones of the melodious Harmonica, whose mellifluous strains breathed indeed

loud blowing of a mail stage horn, in the lungs of a passenger in the close carriage. My lungs felt as if they were dilating, and they continued to impart this sensation of enlargement till I supposed they

——— "the meaning musick of the heart,
To which, responsive, shakes the varied soul;"

and forcibly impressed me with the divine nature of musick, so beautifully suggested by the feeling Collins, where he personifies it, and thus apostrophizes the created being of his imagination:

"O musick SPHERE-DESCENDED maid,
Friend of pleasure, wisdom's aid."*

This mechanical affection of the system is mentioned by Dr. Beattie, who, when speaking of the sources of pleasure derived from melody and harmony, says of certain inarticulate sounds: "It is not altogether absurd to suppose, that the human body may be mechanically affected by them. If in a church one feels the floor, and the pew, tremble to certain tones of the organ; if one string vibrates of its own accord when another is sounded near it of equal length, tension, and thickness; if a person who sneezes, or speaks loud, in the neighbourhood of a harpsichord, often hears the strings of the instrument murmur in the same tone; we need not wonder, that some of the finer fibres of the human frame should be put in a tremulous motion, when they happen to be in unison with any notes proceeding from external objects." "Essays" —Essay on poetry and musick as they affect the mind, chap. vi. sec. 2.

This opinion that a tremulous or vibrating motion in different parts of the human body, may be induced by particular sounds, is corroborated by Dr. Rush, who, in his lecture on voice and speech, says, "the tremours produced in singing are so great, that they are sometimes felt in every part of the body, and some persons have said, that they have felt them in their bones." MSS. Lectures.

* Ode to the Passions.

occupied the whole laboratory with their immensity. I now became totally insensible to the impressions of external things, and the rapturous delight which then entranced my faculties, mars my feeble essay towards its description. This indescribable extacy *must* be what *angels* feel; and well might the poetick Southey exclaim upon experiencing it, that "the atmosphere of the highest of all possible heavens must be composed of this gas."

From these extatical sensations of joy, I was aroused by Dr. Woodhouse, who now endeavoured to take the breathing bladder from my mouth. This I obstinately and violently resisted, holding the pipe with great force between my teeth, and directly began to strike him with frequent blows, which were reiterated with energetick strength, as I was afterwards informed, for I was totally unconscious of any thing that happened during this delirious paroxysm, nor did I recollect it when it was over. The resistance I made was prompted, I suppose, by a sensation I well recollect to have experienced, of some intruding power attempting to remove the cause of my pleasurable inebriety. All my muscles seemed to vibrate, and I felt strong enough to root out mountains and demolish worlds; and, like the spirit of Milton, was "vital in every part." At length I suffered the bag to be taken from me; and as soon as it was removed, felt ten times lighter than the surrounding atmosphere, which prompted a strong and almost irresistible disposition to mount in the air, which I discovered to the spectators by repeatedly jumping up from the floor with great and uncommon agility. My sensa-

tions were just such as I should imagine would be produced by flying. I experienced an unrestrainable inclination to muscular motion, opposing much and powerful resistance to all who endeavoured to restrain me. I resembled those varlets, who, as Ariel tells Prospero, in the Tempest,

> —— —— " were red hot with drinking;
> So full of valour, that they smote the air
> For breathing in their faces; beat the ground
> For kissing of their feet,"*

and feeling like the presiding genius of all I beheld, beat with indignant resentment every person that attempted, vainly, as I supposed, to impede my progress. This superiority that I fancied I possessed over all around me, was so ably seconded by my increased muscular strength, that some of the gentlemen who received my blows, told me they were applied with wonderful and disagreeable force. I seemed to be placed on an immense height, and the noise occasioned by the reiterated shouts of laughter and hallooing of the by-standers appeared to be far below me, and resembled the hum or buz which aëronauts describe as issuing from a large city, when they have ascended to a considerable height above it. I had a sense of great fulness and distension in my head, and my thoughts and perceptions, as well as I can recollect, were rapid and confused, but very unlike any I had ever before experienced. By a sensation as sudden as

> —— " with quick impulse through all nature's frame,
> Shoots the electrick air, its subtle flame,"†

* Act 4, scene 1.

† Darwin's Botanick Garden, Canto 4, line 425.

I seemed to descend from the immense height to which I had flown, and by a quick, but complete prostration of muscular energy, fell into a kind of trance-like state. During the short continuance of this trance, my feelings were placidly delicious, and extremely analogous to those I have often experienced in that state of voluptuous delight, vibrating between a waking consciousness and the torpor of sleep, so elegantly, so feelingly delineated by Rousseau in these words,

> " Thus lifeless yet with life, how sweet to lie!
> Thus without dying oh how sweet to die!"*

To this state syncope succeeded, and I was carried into an adjoining room and placed on a table near an open window. Here I experienced a slight return of the agreeable feelings I have before described, but only of instantaneous duration. The first idea that occurred to me upon my partial revival, was a confused one of *nitrous oxide*, which words I vociferated as I jumped from the table with great vehemence, as I was afterwards informed. I felt much indignation and pride towards the persons around me, and entertained a momentary contempt for every thing that excited an idea in my still chaotick brain. I felt as if I was an inhabitant of the Elysium of Rousseau, † or the island of Calypso, of Fenelon, ‡ blown by a rudely malicious blast into a world of reptiles,

* These lines are the translation of Peter Pindar, Esq.

† *Vide* St. Preux's beautiful description of this enchanting little spot, in his letter to Lord B———, " Eloisa, letter cxxx. vol. 2.

‡ *Vide* Telemachus.

where the atmosphere like the pestiferous *samiel** of the desarts of Arabia, was pregnant with destruction, and threatened inevitable annihilation to all who inhaled its morbid breath. I now, however, as quick as thought, completely revived, and made the mortifying discovery, that the aërial world through which I had been roving with footsteps light as air, was but the fascination of an inebrieting elixity, whose siren spell of pleasure wrapt me in delight.

A profuse diaphoresis appeared all over me, but was particularly abundant on my forehead and cheeks; and the temporal arteries both during the experiment and after it was over, seemed ready to burst with fulness.

The next time I breathed the gas, my feelings were, as well as I can recollect, nearly similar to those just described. In this experiment however I experienced one sensation, that I did not feel in the first, viz. a kind of titillation in my eyes as if water had been dropping between the ball of the eye and its palpebræ.

I must not omit to mention here, that I also experienced in this experiment, and in every other that I made except the one just detailed, a sensation extremely singular. It consisted in a kind of semi-consciousness of my situation, yet unattended by perfect volition. Thus I became enraged as in the preceding experiment, at the vain presumption, as I deemed it, of those who dared to oppose my

* *Vide* Lind. on Hot Climates, part 2. chap. i. séc. 1.

motions, supposing them my antagonists; at the same time I seemed to be sensible they were not so, and conceived myself under the influence of some incomprehensible hallucination, the effect of which, however, I was unable to resist, and of consequence combated with them against my will. I seemed as it were, to have two kinds of consciousness, the one persuading me that I was actually opposed by enemies, the other rendering me sensible, that this was entirely a misconception of the obvious reality, which was that my enemies were indeed no other than friendly spectators, and that their actions which were ostensibly inoffensive, I had misconstrued into the exertion of violence and power against me. Volition, however, was wholly inactive, or, if I may be allowed the expression, paralized; of consequence I derived no benefit from the effect of its operations. I may perhaps illustrate this semi-conscious, semi-delusive state, of which notwithstanding my efforts to describe it, I feel unable to convey a just conception, by the following description of an analogous situation, by the celebrated Kotzebue. It occurred to him during the night after his arrival at Tobolsk, after a fatiguing, an anxious, and distressing journey; he had been, perhaps, affected with a disordered state of his mind, induced by the contemplation of a melancholy exile in the chills of Siberia, separated from his beloved family. "In the course of the night," says he, "a remarkable circumstance took place, the explanation of which I must leave to my good friends, doctors Gall and Hufeland. I had fallen asleep; towards twelve o'clock I awoke, and fancied myself on board a ship. I not only felt the rocking motion of the vessel, but

heard the flapping of the sails, and the noise and bustle of the crew. As I lay on the floor, I could see no objects through the window, except the sky, and this circumstance added to the force of the illusion. I was sensible it was such, and endeavoured to overcome it. I felt myself, as it were, furnished with two separate minds, the one confirmed what I fancied, the other convinced me that it was all imaginary. I staggered about the room, thought I saw the counsellor,* and every thing that surrounded me the evening before, remaining in the same place. I went to the window; the wooden houses in the streets I thought were ships, and in every direction I perceived the open sea. Whither am I going? seemed to say one mind. Nowhere, replied the other; you are still in your own apartment. This singular sensation, which I cannot well describe, continued for half an hour; by degrees it became less powerful, and at length entirely quitted me. A violent palpitation of the heart, and a quick convulsive pulse succeeded. Yet I was not feverish, nor did I feel any headach. My own opinion and conviction is, that the whole must have been the commencement of a species of insanity." †

* The Aulick Counsellor, who had been his escort and guard into Siberia, and who had then left him.

† Kotzebue's Life, written by himself, vol. 1. p. 256.

# DETAIL

OF SOME EXPERIMENTS PERFORMED BEFORE THE CHYMICAL CLASS, IN DECEMBER, 1807.

WITH a view to satisfy some few gentlemen who were still skeptical as to the reality of the effects of nitrous oxide, but more particularly that I might ascertain its effects upon the pulse, I determined again to inhale it once or twice in the presence of the class. I also attended to the state of the pulse, both previous and subsequent to the experiments made by some other gentlemen, of which I shall presently give an account.

Dec. 7. At eleven o'clock, my pulse being at its natural standard 96, and my mind undisturbed, I inhaled five quarts of the gas, having previously made as complete an exhaustion of the air of my lungs as I could effect. The gas was sudden in its operation, and I recognised its sweetish taste as soon as it came in contact with the fauces. My pleasure was less sublime, but more lively than in any former experiments. I had an intense and vivid recollection of the delightful sensations I had before experienced while breathing the gas*—felt a strong inclination to express my delight by speech, and recollect to have found my language incapable of conveying an idea of

* This is a proof of Dr. Rush's position, that the recalling of ideas is owing to the same motion which originally produced a particular idea, being again reproduced in the same place.

*MSS. Lectures.—Lect. on the mind.*

my pleasure, though I was told that I repeatedly exclaimed with rapture and extacy, "*Oh if such is heaven, then indeed it is desirable.*" I experienced more of the tingling in the extremities than on former occasions, and the sensation was extremely pleasurable. My feet tottered under me, as I well recollect, and I fainted, but soon recovered upon being removed into an adjoining room near an open window. Upon my revival I became indignant as before, and beat every one who approached me.

My pulse was now examined by Mr. Cunningham; it beat 136 strokes in a minute—was round, full, and had a moderate degree of tension. I afterwards attended to it myself. In three minutes it beat 132, still full, but soft. In ten minutes 130, slender or thread-like. In fifteen minutes 106, round and somewhat tense. In twenty minutes 61, soft, and intermitting one stroke every three, in both arms. In twenty-five minutes 96, somewhat irregular in frequency, but natural in force. In thirty minutes 84, natural as to force. In thirty-five minutes 96, perfectly natural.

My pupils were very much dilated, as I was informed by those who stood near me, and the adnata so much suffused, as to render my eyes red, apparently inflamed and watery, for the space of twenty-five minutes, after having ceased to respire the gas. The superficial veins of my extremities were affected with a visible engorgement during the remainder of the day. This plethora was greatest in the veins of the fingers, and those on the back of the hand, imparting a disagreeable sensation of heat and tension.

Same day, half past eleven o'clock, Mr. Samuel Jackson inhaled four quarts of the air. He laughed violently and convulsively for about a minute and a half. His face was much flushed and his cheeks bluish. Whilst respiring the gas his eyes were nearly shut, but having placed myself before him to examine his pupils, I found them dilated so much that only a small rim of iris was visible, encircling them. His eye-lids were convulsively retracted after he had respired the gas for some seconds, giving to his eyes a wild and penetrating lustre. I examined his pulse while he was under the effects of the gas, and found it to beat 138 strokes in a minute. The force and fulness after he ceased to breathe the air were not ascertained, but it is presumable both were nearly the same, as a few minutes before, when I had found the last nearly natural, but the force unusually increased. He told me he nearly lost his distinct vision while respiring the air. He felt no depression.

Having perfectly satisfied myself as to the effects of the gas upon the system, whilst the body was in its natural and healthy state; I was anxious to ascertain what would be the immediate and permanent consequences of its operation upon the animal spirits when they were depressed, and upon the system in general when the body was debilitated. With this view I again inhaled five quarts on the 10th December, at 12 o'clock, in the presence of the chymical class. I had been during the whole morning, and was at the time I made the experiment, excessively languid, sleepy, and depressed in spirits, in consequence of

having been much fatigued, by dancing the night before, and from the loss of my accustomed rest. At 11 o'clock I requested Mr. Prioleau to examine my pulse, which he found to beat but 79 strokes in a minute, much below its natural standard, which is 97. At half past 11 o'clock it was still at 79, and at 12 about 80 or 81, its fulness being natural, but its force diminished. I now began to breathe the gas, having previously requested Dr. Klapp to observe the appearance of my eyes, and the changes produced in my countenance. I endeavoured to respire the gas slower than I had done on former occasions, making my inspirations and expirations regular, and imitating, as nearly as I was able my common respiration. I soon perceived the saccharine taste of the gas. I kept my mind perfectly calm, and was determined that it should not be agitated by the exercise of the imagination; endeavouring to abstract my thoughts from the object of my experiment. I believe I succeeded, being for the first three or four inspirations, deliberate and collected, saw distinctly every person around me, and was perfectly sensible of my situation. I heard Dr. Klapp tell me to breathe deliberately, and not suffer my imagination to influence my feelings or actions. I was now, however, very suddenly affected and instantaneously lost my consciousness of what had imparted to me such sublime pleasure. I knew no one; saw nothing; but seemed immersed in a mist, and yet felt an impetuous inclination to express my delight to I knew not whom, nor what. I was told that I repeatedly and vehemently exclaimed, "*heavens, extasies, supreme felicity; Oh that I were a Cooper to act in heaven,*" &c. &c. and then fainted. I was carried from the

laboratory into the yard, where I suddenly revived, with a loud shout, and at the same time leaping up very high. Just before my revival I experienced a sensation analogous to one I have often felt in a dream, when I have supposed that I was falling from an immense height, and just as I have imagined that I should dash my brains out, have awakened and found myself in perfect security.

My pulse was now examined by Dr. Klapp and Mr. Cunningham; it was beating 176 strokes in a minute, being in force and fulness as usual; three minutes after it was found by Mr. Rush to be 130, fulness and force as in common. I now attended to it myself. In five minutes after this 119, full and round; in fifteen minutes 100, very full and somewhat tense; in twenty minutes 99, rather small; in twenty-five minutes 99, regular, somewhat strong, but small; in thirty minutes perfectly natural. The effect of the gas in inducing diaphoresis, that I have before noticed, I again recognised in this experiment, every part of my body, but particularly my head, being covered with a profuse sudor. My eyes were very red and, apparently, inflamed, and my mind was rendered restless and wandering. My *ennui* and lassitude had entirely left me, and I remained in unusual spirits the whole day; in the evening danced a great deal, without experiencing any fatigue. No depression succeeded the following day, though I slept but little the preceding night.

The following observations on the effects of the gas upon my eyes, &c. were communicated to me

by Dr. Klapp. He informed me that my eyes were much protruded from their sockets, widely opened and glassy, and the pupils dilated at least twice their natural size; that, after the effects of the gas had gone off, and whilst my pulse was 176, they were contracted to nearly half their usual size; that the immediate and sudden operation of the gas was evinced by a violent convulsive jump and a shout; that I then breathed on again, and he found a difficulty in removing the bladder from my mouth.

Same day, half past twelve o'clock, Mr. Armstrong inhaled five quarts of this air. His pulse was, previous to the experiment 130, much above its natural standard, being accelerated by agitation of mind from an apprehension that the gas might produce disagreeable effects, never having breathed it before. He appeared to be affected with great pleasure, danced up and down and sang merrily; was affected with vibratory or convulsive twitches in the abdominal muscles about the epigastrium, and right and left hypocondriac regions, also in the muscles of the lower extremities. His eyes, during the time he inhaled the gas were very red and the pupils much dilated. The redness of the eyes continued for more than an hour; his pulse was 160, its fulness and force was not ascertained. He informed me that previous to breathing the gas he had a headach, and a cold in his head produced by wet feet the preceding night, but both were removed by its operation. He experienced no depression the remainder of that day, and slept well at night; but the following one was somewhat debilitated, and felt pains in his abdominal muscles and those of the lower extremities, which

he attributed to the effects of the gas, not knowing to what other cause to refer them, though he thought it probable these feelings might have been accidental at that time, and arising from other causes.

December 11th, Mr. Matthew Cunningham breathed a dose of four quarts, I had previously examined his pulse which I found to be 98, and natural in fulness and force. The gas produced very little effect, but the pupils of the eye were somewhat dilated. He ceased to breathe several times, and when he did so, pinched his nose most convulsively, and was evidently beginning to be affected. The dose I apprehend was not large enough for him. I ascertained the state of his pulse after he had done respiring the gas, and found it increased only three beats in a minute, in other respects being just as before the experiment.

Same day, 12 o'clock, a dose of four quarts was administered to Mr. Robert O. Grayson, his pulse being, according to my examination 84, rather below the common standard, but in other respects perfectly natural. He had an indistinct impression of some singular sensation upon the air coming in contact with his fauces, which however, did not decidedly impart the idea of sweetness; was affected with convulsive and vehement laughter; threw his hands over his head, and seemed merrily happy. His pupils I observed to be immensely dilated, and his face much flushed. He experienced great warmth, and a sense of dilatation in the lungs; thinks his mind was passive, except in one impression, or idea, viz. that he recollected during the time he was inhaling

the gas, the resolution he had previously made to prevent his imagination from influencing his feelings. His pulse I found after the experiment to be 112, increased in force but in fulness perfectly natural. He experienced some slight depression five minutes after breathing, as if fatigued by running; this however soon went off, and he felt unusually lively the remainder of the day, and slept well at night.

On the same day, at half past twelve o'clock, Mr. Drayton inhaled five quarts, his pulse being at its natural standard, 69. The gas imparted a sweet taste, which remained in his mouth some time after its other effects had gone off. He jumped up and down rapidly, throwing at the same time his hands over his head, but did not, whilst affected, utter a single word. He heard a confused murmur or noise, and lost his vision, every thing around him "seeming white." He had a tingling in the extremities, very great pleasure, and felt "light as a feather," having a disposition to ascend in the air. He was semi-conscious, but had no volition. Upon being carried into an adjoining room, was sensible of it, but then lost all recollection, seemed to hear "sweet musick," and fainted. When he revived I examined his pulse, which I found 110, very full and tense; his forehead was covered with a profuse perspiration, and his eyes were then, and had been while breathing the gas, very red. His pupils had been, while under the effects of the gas, greatly dilated, and were then unusually contracted. An hour after, he felt depressed in the lecture room, and was very warm; the remainder of the day, however, he was in usual spirits and excitement.

January 23d, at half past four o'clock, I administered about five quarts of this gas, obtained from some concrete nitrat of ammonia, which I had made some weeks before, to Mr. James Rush. He inhaled it in the presence of six or seven gentlemen, at his own house. His pulse I had previously examined, and found it to be 130 and somewhat tense. It was accelcrated probably, by an apprehension that the gas might produce some disagreeable effects, he having never respired it. After making a complete and full expiration, he began to inhale the gas from the bladder, which he removed two or three times to breathe atmospherick air, and then applied it again to his mouth. His eyes became watery; in other respects were but slightly altered in appearance, and the pupils but little dilated. His face was much paler than usual, and a profuse perspiration covered his forehead and temples. His feelings were very pleasant. He retained his consciousness, he informed me, during the whole of the experiment, though, after the bladder was removed from his mouth, he pinched his nose violently, not seeming to be aware of the ludicrous appearance he exhibited while so doing. He told me that the air imparted to him the smell of nitrous fumes, but no sweet, nor any other taste was perceptible. His pulse I found to be, immediately after he had ceased breathing the gas, 155, having lost its tenseness. He was very desirous of inhaling the gas again, and I administered a dose of six quarts to him at my own apartment, in the presence of half a dozen gentlemen. He inhaled it at half past six o'clock, being exactly two hours after the first experiment. His pulse I found to be 98, and natural in fulness, though a little tense. I did not now remove

the bladder until I supposed he had consumed all the oxygene. He was more violently affected than before, and by his expressions and exclamations, seemed to experience great pleasure, though his countenance was certainly indicative of a very opposite state of feeling. His eyes, as before, were but little altered, the pupils perhaps being somewhat more dilated. When he ceased to respire the gas, he did not remove his fingers from his nose; but pinched it with convulsive force, which one of the gentlemen who endeavoured to remove his arm, found a difficulty in overcoming. A diaphoresis was again produced over his fore head. He informed me that his feelings were as before very pleasant, and he did not entirely lose his conciousness. His pulse was accelerated only 15 strokes in a minute, and still was tense. No depression succeeded the inhalation of these two doses, making together eleven quarts.

I was happy to have it in my power by the following experiment to ascertain the effects of this gas upon the system when disordered and reduced. I had been affected with vertigo, acute and painful hemicrania, and considerable nausea, induced by a violent blow which I had received upon my head by accidentally striking it against the sharp edge of a door. For the relief of these complaints, I lost at one bleeding, Feb. 23, a very large quantity of blood, which much reduced the strength of my system. Thus debilitated, and with an excessive pain in the right side of the head, which the bleeding had not entirely removed, and a disagreeable nervous twitching or kind of convulsive action in the palpebræ of the right eye, I inhaled the gas. As I was rather

apprehensive that the dose to which I had been accustomed, might prove too disproportionate to the increased excitability of my system; I filled a bladder with but two quarts and an half of pure nirous oxide.* It was now past midnight, and I breathed the gas in silence and alone. My pleasure was very serene. I knew not when I ceased to inhale the gas, having unconsciously thrown the bladder aside, and sunk on the bed upon which I had placed myself, absorbed in the most delicious and placid state of semi-consciousness. I think a more calm degree of pleasure will always be induced by breathing the gas when solitary and in silence. I now, however, began to repent of my experiment; and from a very singular and disagreeable sensation in the head began to fear I had increased the complaint. This sensation was somewhat throbbing and painful in that part of the head that was swoln from the blow. These feelings, however, gradually went off, and I determined, in order to make a fair experiment, to inhale the gas again. I now, half an hour after the first experiment, breathed nearly three quarts, being still unwilling, as I was entirely alone, to take enough to produce its usual violent effects upon me. My feelings were precisely analogous to those just described—extremely placid, but unaccompanied with any of an unpleasant nature. This trial entirely removed those disagreeable sensations I have just spoken of. A universal and profuse diaphoresis was soon induced, and an agreeable glow, diffused through my whole system, imparted the most delightful feelings, producing what I would

* I obtained this gas from fibrous nitrat of ammonia.

call heart-felt serenity. No somnolency ensued, but on the contrary I was unable to sleep the greater part of the night. I felt sensibly invigorated by the experiment, the debility I have before noticed, having been entirely removed. Towards morning I went to sleep, and rose perfectly well. From the result of this experiment, I am decidedly of opinion with Mr. Davy, that this gas has the power of removing intense physical pain.

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## SECTION FOURTH.

## ITS EFFECTS

### UPON WARM AND COLD-BLOODED ANIMALS.

FROM the experiments of Mr. Davy* and M. P. Dispan† upon warm and cold-blooded animals, it appears, that they become highly excited, exhibiting convulsive motions with their limbs. Their eyes sparkle, they jump violently about the vessel in which they are confined, and when kept long enough in it, die;—when taken out, however, before life is perfectly extinguished, they experience a temporary recovery from the effects of the gas, so that a healthy action of the vital functions takes place. They sometimes entirely recover, but not always. From the same experiments it likewise follows, that large animals require more of the gas to destroy

* Researches.—Research third,

† Coxe's Medical Museum, vol. 4. No. 1.

them than small ones—and young animals die in a shorter time in it than old ones of the same species. Mr. Davy does not think that their death is owing to the mere privation of atmospherick air, but to some peculiar and positive changes effected in the blood by the action of the gas. He concludes so from having observed in comparative experiments, that animals live twice as long in nitrous oxide as in hydrogene or water,* which would not be the case if their death was occasioned by the mere loss of common air, because nitrous oxide deprives them of this as effectually and as suddenly as either of the other substances. Cold-blooded animals were affected precisely in the same manner.

## APPEARANCES

### OF ANIMALS KILLED IN IT, AS EXHIBITED ON DISSECTION.

In Mr. Davy's account† of the appearances of animals killed in this gas, on dissection, we find but little said about the state of the brain, and as we cannot believe that it was not particularly examined, must infer that in most cases it exhibits scarcely any preternatural appearance: a circumstance truly singular and unexpected. It however leads to one very important conclusion: that we may inhale the gas in large quantities without just apprehension of congestion, extravasation, &c. &c. In some cases, a very slight extravasation of blood into the ventricles of the brain, was observable.

* Davy, page 346. † Researches, page 352.

I killed four kittens in this gas, and dissected them. The general appearances were similar to those mentioned by Davy, though, except in one, no purple spots were observable on the lungs. No morbid appearance whatever was exhibited in the brain. Both auricles and ventricles were somewhat distended with blood, and I found that the heart contracted in two of them for ten minutes after death. In a third, for seven minutes, and in the other, though the sternum was removed immediately after the animal was killed, not the least contraction in either the auricles or ventricles was perceptible.

The purple spots visible on the lungs, in the dissections of Mr. Davy, he supposed was owing to an extravasation of blood from the capillary vessels, in consequence of their coats being broken by the highly increased arterial action.*

## EFFECTS ON VENOUS BLOOD.

It appears from the experiments of Mr. Davy,† that when venous blood was exposed to the action of nitrous oxide, a considerable quantity of the gas was absorbed, minute portions of carbonic acid and azote were evolved, and the colour of the blood was changed into a bright purple.

This fact has been assumed by Dr. Conover, as a proof of his theory relative to the cause of the ver-

* Davy, page 356. † Researches, page 376.

million colour of the blood, as it appears after passing through the pulmonary circulation.* He accounts for this colour on the principle of the different refrangibilities of the rays of *light*, which he supposes one of the three constituents of oxygene gas; this gas he calls a triple compound, consisting of *light*, *heat*, and *oxygene*. He thus accounts for the change effected by nitrous oxide in the blood: "The affinity," he says, "between the oxygene and the nitrogene of the nitrous oxide, is much stronger than the affinity between the oxygene and nitrogene of the atmospherick air; that the temperature of the blood, together with the attraction of the iron therein, being insufficient to disengage much oxygene from the nitrous oxide, consequently less heat is evolved from the partial decomposition of the nitrous oxide, than from atmospherick air, in the process of respiration, therefore the iron in the blood is only oxided in an inferiour degree, which accounts for the fixation of the violet coloured ray (the easiest of refrangibility) and resolves the phenomenon of the purple colour the blood assumes from the effects of the nitrous oxide."

Davy has likewise proved that oxygenated blood may be impregnated with nitrous oxide, and that blood impregnated with nitrous oxide may be oxygenated.† He supposed that the absorption of nitrous oxide by venous blood, was owing to a simple solution of the gas in the blood, analogous to its solution

* Vide his Essay in the Transactions of the American Philosophical Society for the year 1807, now in the press, and to be published shortly.

† Page 387.

in water or alcohol. * The truth of this idea was corroborated by an experiment † he made with a view to ascertain whether the gas was given out by heat. He conjectured it was.

## SECTION FIFTH.

## MODUS OPERANDI.

AS to the mode in which nitrous oxide produces its effects, we are totally ignorant. Conjecture is all that has as yet been offered to account for its operation, and we are not likely to meet with any thing more satisfactory on this interesting subject, until pneumatick chymistry dawns with a yet brighter sun than that which now illumes its sphere.

This gas was supposed by Mr. Davy, to act indirectly upon the muscular and nervous systems. He thought that this operation was effected through the medium of the blood, in the composition of which he was of opinion, it produced peculiar changes. I cannot, however, reconcile to my mind, the plausibility of this theory. The gas affects the brain too suddenly to let us for a moment adopt the idea, that its *modus operandi* is by the tardy rout of the circulation. It cannot either, produce its effect by any primary operation on the lungs; they are a viscus of too hardy a conformation, and too destitute of sensibility for us to suppose they could themselves, re-

* Page 378. † Page 379.

tain and exhibit any impression made by a stimulus like air, whatever might be the peculiarity of its component parts. They however may receive an instantaneous impression, and communicate it, by the delusive sympathy of Hunter, to other parts of the body as the nerves and muscles, or to other viscera as the brain. May not this impression consist in the formation of a matter of a peculiar and infinitely subtle and perfect nature, which shall combine with the nervous fluid and produce such a change in the composition of this etherial organization of animal matter, as will enable it to pass along those channels in the nerves through which it is accustomed to flow in common life, with an inconceivable rapidity of movement that shall produce the most supreme degree of exquisite feeling and pleasure, possible? All however, that we can advance to explain the incomprehensible mode of operation, by which this wondrous substance induces its effects, is but the offspring of vague conjecture. It promises like the effects of magnetism, to remain among the inviolable arcana that human knowledge will never be enabled to divulge, and we must be contented by the reflection, that "*ita se habet, quia se habet.*"

The various and dissimilar effects of this gas upon different individuals, proves that its operation depends in some measure upon the peculiar organization of the animal constitution of different persons. They will, I believe, generally be affected by it, as differently as they are variously constituted in their capabilities of experiencing the extreme of other emotions or sensations, whether they be of a pleasurable or painful nature.

I believe, with Mr. Davy, that nitrous oxide acts in the destruction of life, by inducing the highest possible excitement, ending in læsion of organization.

## SECTION SIXTH.

## PERMANENT EFFECTS

### ON THE INTELLECTUAL AND CORPOREAL CONSTITUTION.

WE are, as yet, but little acquainted with the permanent effects of this philosophick wine, upon the corporeal system, and are still more in the dark respecting its durable operation, if any such it have, on the intellectual constitution. Is it not probable, however, that the latter, by the continual excitement of this intellectual drink, might be increased in vigour and brilliancy? "May there not," says Dr. Rush, in his lecture on the influence of physical causes upon the intellectual faculties,* "be some production of nature or art, yet undiscovered, that shall act in such a manner upon the brain, as to enlarge and strengthen the intellectual faculties, so as to enable them to accommodate to difficulties and emergencies, in the contemplative and active pursuits of life?" And does not this aërial stimulus, I would answer, which imparts such vivid energy, such exhilarating liveliness, such novel and elevated ideas, to the greedy inhaler, seem to promise by the virtues it exhibits, even in its present infant state, to be this desired production? For, this gas, like the liquor called Perganum, with which Kempfer says he was treated in Persia, "produces, suddenly, the most

* *Vide* his Introductory Lectures, page 119.

extravagant sensations of joy," though it does not, like it, leave its devourers "with an oblivion of all that is seen and done during the paroxysm of mental delight." And may not this subtile invisible fluid, prove to be the "substance" that Dr. Rush supposes* there is a "probability does exist upon our globe, that produces similar transports in the exercises of the intellectual faculties." And if three cubebs, as mentioned by Etmuller, taken every day, have a wonderful effect in invigorating the memory, may not the occasional or daily inhalation of a few quarts of this airy beverage, this *boisson intellectuelle*, increase the quantum of genius in our country?—A desideratum, certainly, of supreme importance. It is no very chimerical idea, that the intellectual faculties may be strengthened and improved by respiring an air; for Johnson observes that it is "universally known that the faculties of the mind are invigorated or weakened by the state of the body, and that the body is in a great measure regulated by the various compressions of the ambient element."† Here he supposes the atmosphere to act primarily upon the body, and secondarily on the mind; now the nitrous oxide is productive of vigorous effects upon the corporeal system, and I would suppose its permanent invigoration of the intellectual faculties to be produced by a similar mode of operation. "The effects of the air," he continues, "in the production or cure of corporeal maladies, have been acknowledged from

* *Vide* his Introductory Lectures, page 119.

† Rambler, No. 117.

the time of *Hippocrates;* but no man has yet sufficiently considered how far it may influence the operations of the genius, though every day affords instances of local understanding, of wits and reasoners, whose faculties are adapted to some single spot, and who, when they are removed to any other place, sink at once into silence and stupidity. I have discovered, by a long series of observations, that invention and elocution suffer great impediments from dense and impure vapours, and that the tenuity of a defecated air, at a proper distance from the surface of the earth, accelerates the fancy, and sets at liberty those intellectual powers which were before shackled by too strong attraction, and unable to expand themselves under the pressure of a gross atmosphere. I have found dulness to quicken into sentiment in a thin ether, as water, though not very hot, boils in a receiver partly exhausted, and heads, in appearance empty, have teemed with notions upon rising ground, as the flaccid sides of a football would have swelled out into stiffness and extension."* If, then, one may hazard these ideas, relative to the effects of our panacea in invigorating the mind, may we not sport a conjecture as to its capability of protracting age. This is not a more chimerical speculation than that which suggested the possibility of renovating life by the transfusion of the blood of young people or other animals, into the veins of old persons; and yet this art was actually practised in former years in France, and,

* Rambler, No. 117.

as has been asserted by some not without success,* though others declare madness was the consequence of it.†

## SECTION SEVENTH.

## APPLICATION

### TO PNEUMATICK MEDICINE.

THE subject of this essay is one of the pillars upon which the superstruction of the science of Aërial Pathology was effected. This science, as I would call it, since it necessarily involves principles, was the offspring of that æra, which witnessed the disco-

* Darwin mentions this fact, and he actually contemplated essaying its effects upon lady Northesk, who was arrived at the utmost verge of this life, in a deep decline. He told her one evening that she should not die prematurely if his efforts could prevent it; and said to her that "an art was practised in former years, which the medical world has very long disused; that of injecting blood into the veins by a syringe, and thus repairing the waste of diseases like yours. Human blood, and that of calves and sheep were used promiscuously. Superstition attached impiety to the practice. It was put a stop to in England by a bull of excommunication, from some of our popish princes, against the practitioners of sanguinary injection. That it had been practised with success, we may, from the interdiction, fairly conclude; else restraint upon its continuance must have been superfluous."* His patient consented to have the trial made, but the doctor, from the difficulty of procuring the proper instruments, and lest his reputation should suffer by the failure of the experiment, relinquished all thoughts on the subject.

† Dr. Rush mentions that madness was produced by this practice of transfusion. MSS. Lectures. Lecture on the Diseases of the Mind.

* Life of Darwin by Anna Seward, page 79.

very of the gasses. Its history is included in an account of these, and its progress was commensurate with the gradual development of their properties. Aërial Pathology is yet in its infancy, but notwithstanding its anomalous effects is a child of great promise. Witness the astonishing and well authenticated cures,* which have already been performed by its yet embryo hand, and say—does not the anticipation of its maturer growth, impart the most flattering expectations. It has as yet conducted us only to the threshold of that temple, in which at a future and more enlightened period, we may perhaps learn the art of curing some of the diseases of the human body by means of pneumatick medicine. Who can say, but that a more intimate knowledge of the nature of the gasses, a more definite acquaintance with their operation upon the healthy and morbid systems, and an accurate idea of their proportionate doses, as adapted to various constitutions and idiosyncracies of habit—may render them as powerful and indispensable implements in the hands of physicians, as mercury or the lancet. Considerable advances have already been made towards the addition of aërial medicines, to the materia medica. In the year 1799, a medical pneumatick institution was established in Bristol, England, for the purpose of administering some of the gasses in different diseases, of which Mr. Humphrey Davy was appointed superintendent. The gasses principally employed were oxygene and nitrous

* These cures have been effected by oxygene gas; an air which, wonderful to relate, as recently as the year 1774, only Dr. Priestly and a mouse, had experienced the pleasure of breathing.

oxide. Some interesting accounts of the happy results of experiments made with the first of these airs in its pure and diluted state, by doctors Thornton, Beddoes, and others, will be found in the different volumes of Tilloch's Philosophical Magazine.

## OF ITS EFFECTS IN PARALYSIS.

The wonderfully stimulating effects of nitrous oxide on the healthy and vigorous constitution, and its peculiar operation on the nervous system, led Mr. Davy, Dr. Beddoes, and others, to suppose that in such diseases as were evidently produced by a defect of nervous energy, or in other words a deficiency or degeneracy in the nervous fluid, it promised to prove useful. They concluded therefore, that either in cases of hemiplegia, or general palsy of the muscles, not consequent upon any visible organick læsion, it might be productive of permanent and happy effects. They therefore tried its effects in these cases. A full detail of the results of their experiments upon paralytick patients, will be found in "Beddoes' Notice." These trials embolden us to conclude, that it promises to prove a valuable remedy in diseases originating from deficient irritability and sensibility, or from a morbid and modificated state of these vital principles.

* The happy effects of nitrous oxide upon the hemiplegic patients, would seem when we reflect upon the stimulant property of the gas, and the nature of the disease, a little extraordinary. For Mr.

* The observations that follow this mark do not now first appear here; they were read in the form of an essay for discussion, before the Philadelphia Medical Society, February 20, 1808.

John Hunter asserts, and his inferences are drawn from experiment, that nervous debility is not the cause of this disease, and that therefore in cases of hemiplegia and apoplexy, which he believes to be the same disease, differing only in degree, since they both arise from extravasations of blood in the brain, the application of powerful stimulants as electricity, is an improper and extremely injurious mode of treatment. "For many years," says Mr. Hunter, "I have been particularly attentive to those who have been attacked with a paralytick stroke, forming a hemiplegia. I have watched them while alive, that I might have an opportunity to open them when dead; and in all I found an injury done to the brain, in consequence of the extravasation of blood. I have examined them at all stages, when it was recent, some of weeks standing, others of months, and a few of years, in which I saw the progress of reparation."* From these observations of Mr. Hunter, we are forcibly struck with the extraordinary circumstance of hemiplegia and other paralytick affections having been cured by so stimulating a substance as nitrous oxide. But the facts, as they are established upon the testimony of Davy and others, are stubborn, and we can only explain them by supposing the nitrous oxide, from its particular determination to the brain, had stimulated that organ to produce a new and healthy action, thereby inducing a power in it, to influence the voluntary muscles; for the condition of the brain either in general or partial paralysis, is such as to be wholly unable to perform volition, that is to influence the voluntary muscles of the whole body in universal palsy, or of a particular

* J. Hunter on the blood, &c. vol. 1. p. 203.

part, should the affection be partial, of one side in hemiplegia, or of the lower limbs in paraplegia.

In recent hemiplegia, supervening upon a complete or confirmed paroxysm of apoplexy, the treatment should be nearly the same as in this last affection.* Hence, then, in recent cases of hemiplegia, stimulants in general are dangerous,† and of consequence nitrous oxide improper. But, in the more protracted or chronick state, where there are no evident marks of compression, and where a plethorick state of the blood vessels of the brain cannot be suspected to have brought on the disease, or where no suspicion is entertained of these vessels possessing such a disposition as would tend to produce congestion, the use of nitrous oxide is certainly no longer ambiguous. It is in such cases then, we are to presume, that this air has done good.

Having mentioned those affections, in which, from actual experiment this aërial medicine has been proved serviceable, I will now venture to throw out a few suggestions as to the probability of its happy administration in other diseases.

* "The cure of hemiplegia, on its first attack, is the same, or nearly the same, with that of apoplexy; and it seems requisite that it should be different only, 1. When the disease has subsisted for some time. 2. When the apoplectick symptoms, or those making considerable compression on the origin of the nerves, are removed; and particularly, 3d. When there are no evident marks of compression, and it is at the same time known that narcotick powers have been applied." Cullen's First Lines 1153.

† First Lines, 1154.

## OF ITS EFFECTS

### IN SUSPENDED ANIMATION.

THIS name has been applied to the disease produced by submersion, strangulation, and other similar causes. By whatever cause it may have been produced, however, it is owing to an inability of the heart to perform its healthy functions, and our immediate object when we attempt to resuscitate this suspended life, is to renew or excite its natural contractions The proper and prompt attainment of this object, consists in the application of heat to the body, and the introduction, by artificial means, of air into the lungs. Atmospherick air has generally been recommended for this purpose, by writers on the subject. Dephlogisticated air, however, according to Goodwin,* has been found to recover small animals more expeditiously than common air; and oxygenated muriatic acid gas has been highly extolled. Hence we may infer the probability, that the more stimulating properties of nitrous oxide, would indicate its superiority over either of these gasses. It might be employed in the manner recommended by Goodwin, for the injection of atmospherick air into the lungs,† taking care to observe the same caution as to the quantity of the injected air; for it will be necessary with this gas, as with common air, to inflate the lungs with a large portion,‡ so that it may reach their remote cells, which will

* On Respiration, &c. section 7. † Ibid page 57.

‡ Goodwin says 100 cubick inches of atmospherick air should be thrown into the lungs of an adult at each inflation of them, and should be carefully drawn out again before more be introduced. On Respiration, page 54.

thereby become uniformly distended, in consequence of which the pulmonary veins, the sinus venosus, and left auricle, will be subjected to its action.

In cases where a great quantity of water is insinuated into the small branches of the trachea, and into the air cells of the lungs, so that the application of the gas sufficiently near the sinus pulmonalis, and left auricle, to change, or otherwise act upon the blood contained in them, is impracticable, the instrument recommended by Goodwin,* to extract the water from the minute ramifications of the bronchial vessels, ought to be used.

## OF ITS EFFECTS IN TETANUS.

This disease, I believe, as Dr. Rush† has supposed, is founded in debility and relaxation. The indication for a cure, therefore, consists in restoring the natural vigour of the system, and also in inducing a degree of inflammatory diathesis in it. The disease is seated exclusively in the muscles, and while they are preternaturally excited, the blood vessels are in a state of reduced excitement, as is proved by the slow and feeble pulse which always is present in this affection, and the dissolution of the blood, which in this case, is the effect of the abstraction of all action in the sanguiferous system.‡ Now, from this theory

* On Respiration, section 7, page 55.

† Medical Observations and Inquiries, Vol. I.

‡ Rush's MSS. Lectures.

of the disease it obviously results, that such remedies are indicated for its removal; as act by surpassing in force, the strength of the system, thereby exciting a stronger but less diseased action. It is also evident that these remedies must be stimulants, and those of a most powerful nature, which will act by prostrating or forcing down, or perhaps expending muscular excitement.

The common stimulating remedies, as the cold and warm baths, oleum succini, pisselæum Barbadense, balsam of Peru, mercury, wine, bark, and blisters, are all too feeble to produce this effect. Dr. Rush, in the "Observations" alluded to, says he has heard of electricity having been advantageously used in tetanus, but that he had no experience with it. We know however, that it has been successfully used in New England in tetanick affections, as appears from a publication of the Medical Society at New Haven. Now nitrous oxide is a still more powerful stimulant, at least as respects this effect upon the human constitution, and equally sudden in its operation. We have seen that it wonderfully augments muscular energy, and that it increases the pulse very much in frequency and somewhat in force. We have said likewise that in tetanick affections, while the muscles are in a state of high and morbid excitement, the pulse indicates an unusually reduced state of arterial action. Now would not the nitrous oxide, by powerfully affecting the muscular system, thereby prostrating or expending its preternatural excitement, at the same time inducing a temporary inflammatory diathesis in the blood vessels, which would

abstract the remaining morbid excitement from the muscles, have the effect of equalizing it, and thus curing the disease? Besides, by the action of the nitrous oxide, the brain is for a short time violently affected; hence another good reason for supposing this gas would remove tetanick complaints; for we are told by Dr. Rush* that a fit of drunkenness had cured a tetanus by causing a temporary violence to the brain, thereby removing the preternatural excitement in the muscles. Such probably would be the effect of nitrous oxide.

## ITS EFFECTS IN LOW TYPHUS FEVER.

If caustick, a coal of fire, and boiling water are sometimes necessary and proper in the lowest stage of typhus fever, when life is nearly extinct, what would be the effect of nitrous oxide in similar cases?

## OF ITS EFFECTS IN MANIA.

WHAT would be the effects of a long and daily administration of the gas in the different states of mania? No experiments indeed have as yet been made to confirm the probability of its usefulnes in this distressing disease, but we hope, that at a more enlightened period of medical science, it will not escape that attention which it seems

* MSS. Lectures—Lecture on the operation of stimulants

to merit. No stone ought to be left unturned in searching for a remedy, for one of the most calamitous misfortunes that man is doomed to bear. Go, and contemplate the "utmost exacerbation of human misery"* that meets you in the murky cells of an hospital—and then, if aught of sympathy dwells within your hearts, say if that is a visionary and useless speculation, which calls for the exertion of every untried cure for wretchedness like this. When all other endeavours then, to retrieve the lost, bring back the wandering, or recover the "hurted mind," to reason and to happiness, have been baffled—let us essay the effects of aërial medicine. Let us not be deterred from so humane a purpose, by the reflection that its effects are temporaneous. Perseverance and the habitual administration of it, for months, nay years, may effect more than our most sanguine wishes now lead us to expect. It is true that the hope we entertain of the success of this remedy is but slender, but we ought to catch at it with a drowning grasp, and cherish it with care. However faint, it may yet serve to guide us; however distant—it may yet serve as an object to invite us to our goal. We should pursue it with ardour, and fix on it a rivetted attention—it may lead us to one more deserving our regard. The feeble light of the glow-worm, though its rays are dim, discovers to us sometimes, a neighbouring gem which would have else escaped our notice. Let us then follow up this hope, and should it prove nothing in itself, it may assist us in obtaining our grand desideratum, by

* This is the happy and nervous expression of Dr. Johnson.

pointing out the path which leads to its site. The ignis fatuus that we have pursued with anxious look, and that vanishes when we think it within our grasp into an "empty nothing"—often carries us in safety through many a murky fen; and while its vapoury rays point out through the "thick-wove night," the rugged precipice and thorny path, it directs us to the sure and safer road.

Thus have I, truant as I am, strayed from the beaten path of established truths in medicine, to wander for a moment through the labyrinths of vague uncertainty. It is true I have sauntered with idle step, and returned without having culled a single flower of lasting hue, or even plucked, perhaps, a bud that can be fostered into bloom. It is true, I come from my excursion loaded only with the fascinating illusions of speculation. It is true that these speculations, with which I have beguiled the *tædium* of a few hours, rendered sombre and uncheery by reflecting on the miseries of my fellow beings, may be called the offspring of fancy and hypothesis; but it is equally true that they are innocent and humane. Innocent, since they hazard nothing, and ask but a retired corner in the temple of theoretick medicine—humane, since they only invite us to essay every remedy in our power, to alleviate the miseries of mankind. They may elicit a further and an experimental prosecution of the subject; for speculative postulations often lead to experiment, the touch-stone of reasoning and the test of truth. But call them what you please—the veriest essence of chimera, the fantasies of a dream, or what not; I will yet venture to cherish them. The human mind delights to rove

through the flowery fields of speculation, and scarce can two connected facts present themselves to its observation, than it immediately infers some consequent conclusion. If these are illusions that "have *cheated* while they *charmed* the dazzled mind,"* they have afforded me a pleasure that is not alloyed by a consciousness of their instability and hypothetical nature. If they are the phantoms of a dream, that when I wake shall be melted into air—I will yet dream on and exclaim with Ferdinand in the Tempest,

> "This is a most majestick vision, and
> Harmonious charmingly."†

* Metrical Fragment.—Vide "Lay of an Irish Harp," page 56.

† Act 4, scene 1.

IN following the impulse of my feelings, I cannot leave this University, without tendering in the only publick manner which perhaps will ever proffer itself, my most grateful and sincere acknowledgments to its enlightened Professors. Collectively as a faculty, and individually as gentlemen, they claim my highest regard. With professors Rush and Woodhouse I have had the pleasure of a more intimate acquaintance, which I need not add, I well appreciate. Receive then, gentlemen, the sincere thanks of the heart, the only return for your politeness I can offer; and be assured that you, as well as the other professors, will ever possess the highest respect of your grateful pupil.

THE END.